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Edited by H. H. Brown, A. M. Inst. N. A.
Member Soc. N. A. and M. E.

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America's Opportunity

WITH the exception of her navy, now the second largest in the world, the United States has not scored heavily in recent years as a maritime nation. In overseas commerce, American ships have been a negligible factor. Shipbuilding has been limited to the needs of our protected coastwise trade, the commerce on the Great Lakes and inland waterways and the requirements of our navy. Due to the failure of the Government to enact legislation to enable the merchant marine to compete with the more cheaply operated vessels of foreign nations, the American flag has been practically driven from the high seas.

But with the advent of war the folly of ignoring our maritime interests has been so strongly driven home that further negligence in this respect is unthinkable. The emergency fleet, now being created at enormous expense under war conditions, places a new responsibility upon the nation. The future of American shipping has become one of the great national problems that will require an immediate solution. The Controller General of Merchant Shipbuilding in Great Britain does not hesitate to predict that too many ships cannot be built in the next ten years and that all tonnage produced in the next five years will be fully occupied without leading to trade wars or dangerous rivalries.

With such prospects in view, can we afford to delay in shaping a definite policy for the upbuilding and maintenance of American shipping in foreign trade?

American Shipbuilding in 1918

TO those who a year ago enthusiastically predicted an output of about 6,000,000 deadweight tons of merchant shipping from American shipyards in 1918 the results will undoubtedly be disappointing, but it will be remembered that at the same time experienced shipbuilders voiced the opinion in these pages that if things did not break too badly the shipbuilding industry of the United States might turn out 3,000,000 deadweight tons of merchant shipping during the year. As the total production in 1917 was about one and a quarter million tons, this meant an addition of about two million tons in a year, a rate of expansion which no nation had hitherto succeeded in attaining. As matters have turned out, this conservative estimate has been so nearly accurate that the difference is negligible.

According to the incomplete returns supplied by the Shipping Board, published elsewhere in this issue, an output of 3,000,000 deadweight tons was reached early in December. About 48 percent of the tonnage was produced on the Pacific coast, 28 percent on the Atlantic coast, 22 percent on the Great Lakes, and 2 percent on the Gulf coast. Of the total tonnage delivered to the Shipping Board, 87 percent was steel, 12 percent wood, and 1 percent composite construction. The largest output was from the five great yards of the Bethlehem Shipbuilding Corporation, Ltd., on the seacoasts, and the second largest from the yards of the American Shipbuilding Company on the Great Lakes. The largest cargo vessel delivered during the year was a turbine-driven steel steamer of 12,500 tons built at the Pennsylvania plant of the Pusey and Jones Company, while the average size of steel cargo vessels produced was 8,800 tons deadweight.

As far as the production of steel vessels requisitioned by the Shipping Board is concerned, the actual deliveries came within about 3 percent of the required schedule, but the output of steel contract vessels fell 54 percent behind the schedule and the output of wood vessels represented a failure of 80 percent. The failure of contract steel ship deliveries is accounted for by the delay in the work at the three great yards built by the Government for the assembly of fabricated ships, from which a production of over a million tons was scheduled by January 1.

In spite of the failure to meet the Shipping Board schedule, which was not unexpected, the American merchant marine is to-day expanding more rapidly than that of any other nation in the world. In August the United States became the leading shipbuilding nation in the world. It now has more shipyards, more shipways, more shipyard workers, more ships under construction, and is building more ships every month than any other country, not excepting the United Kingdom, which hitherto was the first shipbuilding power. And so far the effect of the fabricated ship programme has hardly been felt. In the coming months this will add enormously to the output of merchant shipbuilding.

Port and Harbor Facilities

OF vital importance to the development of the American merchant marine and the expansion of our foreign trade is the immediate provision of adequate pier and cargo handling facilities at the principal ports. Steamship companies are complaining of the congestion at New York, where the heaviest volume of overseas trade is handled, while the port authorities in Philadelphia, which stands second in the volume of traffic handled, claim that their facilities are not being used to more than fifty percent of their capacity.

The Port and Harbor Facilities Commission of the Shipping Board, composed of E. F. Carry, chairman; Major-General W. M. Black, U. S. A.; Colonel Bion J. Arnold, U. S. A.; Dr. J. E. Greiner, of Baltimore; H. McL. Harding and Calvin Tomkins, of New York, and John Meigs, of Philadelphia, is endeavoring to work out a consistent plan for enabling the country not only to use all of its available port facilities to their full capacity but

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also to develop them to a higher efficiency and to provide additional facilities of the very best type. A thorough investigation has been started as to harbor and terminal facilities in every port as well as of the comparative cost and efficiency of various methods of handing cargoes (with special reference to mechanical freight handling appliances) and the needs for bunkering, repair and dry docking facilities. So far the commission has recommended to the Shipping Board the construction of dry docks or marine railways and commensurate repair plants at Boston, New York, Philadelphia, Norfolk, Pensacola, Astoria, Seattle, Portland, San Francisco and Los Angeles and has secured authorization for the immediate construction of two 20,000-ton and eight 10,000-ton floating dry docks, which are to be located in the ports where the need is most urgent. But the provision of adequate repair and dry docking facilities, essential as it is (rated first in importance by the Controller General of British Shipbuilding), is only one of the needs in port development in the United States that requires immediate attention. By far the most pressing need is the improvement of cargo-handling facilities, so that both present terminals and future additions can be utilized at higher capacities.

Great Britain is facing the same problem, and in an address delivered at a recent meeting of the Institution of Civil Engineers, Sir John A. Aspinall, president of the Institution, pointed out the lack of mechanical equipment at important British seaports, recommending the following methods of supplying the deficiency:

"It must be remembered that the problem of loading and discharging ships is by no means the easy matter which some people suppose, and the very difficulties—not of a mechanical nature—make it the more necessary to have quick and cheap handling of freight so that every farthing per ton can be saved in manipulation, and pier space, which is always costly, can be rapidly cleared. Customs regulations require examination of imported goods, and nearly everything taken out of the ships must be put down on the ground to be looked at, and this alone necessitates double handling.

"Exports again cannot always be put on board ship at the moment of arrival alongside, as a vessel to call at many ports must have her cargo in systematic order, not only in the order of the ports, but also in relation to the character and weight of the articles exported. This means storage in transit sheds before loading and the picking out, sorting and lifting, very often twice over, of the goods which have arrived. All of these little points add to the necessity of eliminating hand labor and doing by quick-acting machinery that which is necessary to hurry the vessel away to sea, and thus increase the number of voyages per annum.

"Electric overhead travelers, such as are now used in most modern railway transit sheds, with a longitudinal traverse of 450 feet per minute, and a cross and lifting speed of 150 feet per minute, are probably the most suitable appliances for this work inside the sheds, while outside there should be a liberal supply of quick-acting jib cranes. At the most modern railway freight stations, where the same freight has ultimately to be handled, these quick-acting appliances, in combination with the modern electrically propelled platform trucks, have been the cause of great economies.

"In every case, apart from those where difficulties have been mentioned, cranes and other appliances should load direct from the ship to trucks or railway cars, and from cars to the ship, though it is extraordinary to find how little provision has been made for this direct loading to transport vehicles at many large ports."

Full-Sized Ship Experiments

NUMEROUS cases are on record where good results have been obtained by alterations made to full-sized ships after they have been completed. Trial trips have been run both before and after the alterations, and in this way a trustworthy estimate has been made of the difference in performance.

At the spring meetings of the Institution of Naval Architects in 1917, Sir E. Tennyson d'Eyncourt, for instance, recalled the case of two ships built about seventeen years ago. After they had been in service for some time, he suggested that the bossing, which was nearly horizontal, was not at a suitable angle. On one of the ships coming back to the works, it was therefore decided to alter the angle to something approaching 45 degrees, and, in addition, the casting was fined at the aft end as well as the lines of the bossing itself. At higher speeds, much better results were obtained than with the old horizontal bossing, but the improvement did not maintain itself at lower speeds. This showed that the improvement was due to the angle of the lines. After the ship had been in service for some time it was found that so much coal had been saved that her sister ship was sent to have a similar alteration made to her bossing.

Sir Archibald Denny, at a meeting of the North-East Coast Institution of Engineers and Shipbuilders in November, 1915, instanced a rather curious case of alterations made to a full-sized ship where it was found that the bad performance of the vessel was not due to the suspected cause but to something entirely different. When the vessel was built her bilge keels, which were very long, were not put on normal to the bilge, as they would have been out of the water at the ends, the angle of the diagonal plane of the keel being reduced. When the vessel was tried on the measured mile, her efficiency was found to be very low. Some one suggested that the bilge keels were the cause of the trouble, and a length of 20 feet was cut off from each end of both of them. This causing no appreciable difference, the bilge keels were taken off altogether, and the reduction in the resistance was found as nearly as possible to be quite normal. Later it was seen that there was a lack of surface in the propellers, and when new propellers were put on the efficiency came up to expectations. This, however, did not explain the fact that in an almost identical ship with similar propellers proper results had been obtained, and Sir Archibald Denny has stated that to this day he is not able to explain with certainty why the results were so different. Another case quoted by him was that of a channel steamer. In order to get the maximum result, mastic was placed behind each butt and washed off into the general surface. This was done for some years, but when the mastic cracked off it was not replaced, because there was no apparent differences in the speed on service with or without it.

Admiral Taylor, in his "Speed and Power of Ships," refers to the steamer *Niagara*, a yacht about 250 feet long, in which the shaft brackets were nearly horizontal. She was given two six-hour trials under similar conditions. In the first the screws were inward-turning, and in the second were interchanged to be outward-turning. The horsepower developed on each trial was very nearly the same, but with the inward-turning screws the average speed was 12.8 knots, whereas it was 14.12 knots with outward-turning screws.

Admiral Dyson, the propeller designer of the United States Navy, has instanced a case of two oil-fuel barges built for the Navy Department. These vessels were designed for a speed of six knots, and everything indicated

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that the speed could be easily obtained with the power. After trying several different propellers, however, the highest speed realized was only 5¼ knots. It was thought that the action of the water indicated that a portion of the feed was being drawn from astern, and, as the cheapest remedy, the line of shafting was changed so as to lower the propeller about 3 feet, although the lower blade projected below the line of keel. In this new position, with propellers of the same pitch and surface but of 5 inches greater diameter, a speed of 6¼ knots was obtained with the same power as before. The greater portion of this increase in efficiency of the propeller was due to increase in diameter, and the remainder to the change in position, but the increase in diameter was rendered possible by the lowering of the shaft.

Many other examples could be given, but those mentioned are sufficient to show the benefits that may be derived by making alterations in consequence of careful observations of a ship's behavior in service. The cost of carrying out the alterations must vary, and in some cases will no doubt amount to a fair figure. On the other hand, the large saving brought about by the reduced fuel consumption, which operates during the whole lifetime of a ship, will more than balance even a considerable outlay on such alterations. When this is generally realized, it can be confidently stated that enormous economies will be effected in ship propulsion.

The British Standard Ship

THE standard ship now being built in British shipyards to make good the loss of tonnage due to submarine warfare is of about 8,000 tons, and all the ships already laid down are of identical pattern. Eight thousand tons seems to have been hit upon as a middle size between 6,000 and 10,000 tons. An 8,000-ton ship shares with the 6,000-tonner the ability to enter virtually any port—a matter of considerable importance—and it has this advantage over the 10,000-tonner, that for every 40,000 tons built, the risk of loss is divided among five ships instead of four. An eye has also been kept on the after-war value of the ships, and it is claimed that the owner who would prefer either a 6,000- or 10,000-ton ship could without much inconvenience put up with a ship to carry 8,000 tons of coal or grain.

There is, of course, no question of the capacity of the shipyards to make good the wastage of merchant ships when their energies are turned in that direction. The trouble has been to get the rolling mills to turn out the plates and sections with the necessary quickness. The standardization of a large number of ships will permit the rolling mills to work for long spells without alteration of the machinery, and this will greatly increase the output.

The North-East Coast Engineers have already solved the problem of standardizing the reciprocating engine, but there are two opinions about the standardization of the hulls. Some shipbuilders contend strongly that the best and quickest method would be to allow individual yards to standardize their own type of ship. As a matter of fact, shipyards already have what may be called their standardized ship, with which their designers, foremen and workmen are perfectly familiar; and the argument is that, provided the requisite materials are forthcoming—a rather big provision—the yards would build more quickly when working in the accustomed groove. The opposing argument is based upon the fact that the materials cannot be produced fast enough when the orders received are for sections of varying sizes, and that rapid output is at the moment of supreme importance.

Our Merchant Marine

THE United States Shipping Board is calling upon all Americans to give their undivided support to the merchant marine. Chairman Edward N. Hurley recently wrote to the president of an association of manufacturers as follows:

"Your letter is one of many I have received from American business organizations pledging hearty support of the American merchant marine. I am glad to know that so fine a spirit of team work exists in your organization.

"You ask what your organization can do. The first thing is to become acquainted with our merchant marine as Americans. Quite a number of business men write that they do no foreign trade and think the American merchant marine does not affect them, or they see no way to back it up because their community is far from the ocean. There is only one legitimate excuse for not being interested in the American merchant marine—that is, if you are not an American.

"You ask what can be done by a live merchant marine committee in your organization. The first task is to pull your membership and your industry or community together behind our new ships and begin spreading information about them. The members should know something about what we are doing; how many ships we are building; how many ships are flying the American flag, and whether we will do foreign business or not.

"This is the biggest national improvement that we have ever tackled. Measured in money it represents fifteen times the investment in the Panama Canal, and measured in time we are doing the job about five times as fast. It was American understanding and enthusiasm, not selfish interest, that dug the big ditch from Colon to Panama. We must all get on the job as Americans now and put through the merchant marine, because, like the Panama Canal, it is the right thing to do for the United States and the world.

"The first great task is to organize on this issue of the merchant marine and create a healthy, unselfish national curiosity about it. I want you to realize that the American merchant marine is going to take you into a new era. When peace finally comes we must be prepared to put our American spirit and energy at the service of other nations. They will need our money and our tonnage, our ability and team work in developing their resources. It isn't what we are going to get out of it that counts so much as what we are going to put into it. Read the Webb Act, which authorizes combinations for foreign trade. This is an epoch-making law full of wonderful possibilities for team work.

"Study foreign countries. Every man in this country to-day should be reading about the peoples and resources, ideals and needs of Latin America, Australia, South Africa, Canada, Mexico, the Orient and Europe. It is time for every business man to become a specialist in the literature of some quarter of the globe. It is time for American youth to dream dreams of foreign countries and cultivate the natural love of the sea and travel possessed by every healthy boy. It is time to study language. Spanish-speaking peoples have a future that will soon surprise the world.

"The organizing of true Americanism behind the American merchant marine is one of the most important tasks of the United States Shipping Board. It would be of little use to build these ships if we could not line every American up behind them."

This is a call for action to every true American. Pass the word along.

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LETTER TO THE EDITOR

Analysis of Shipyards Organization

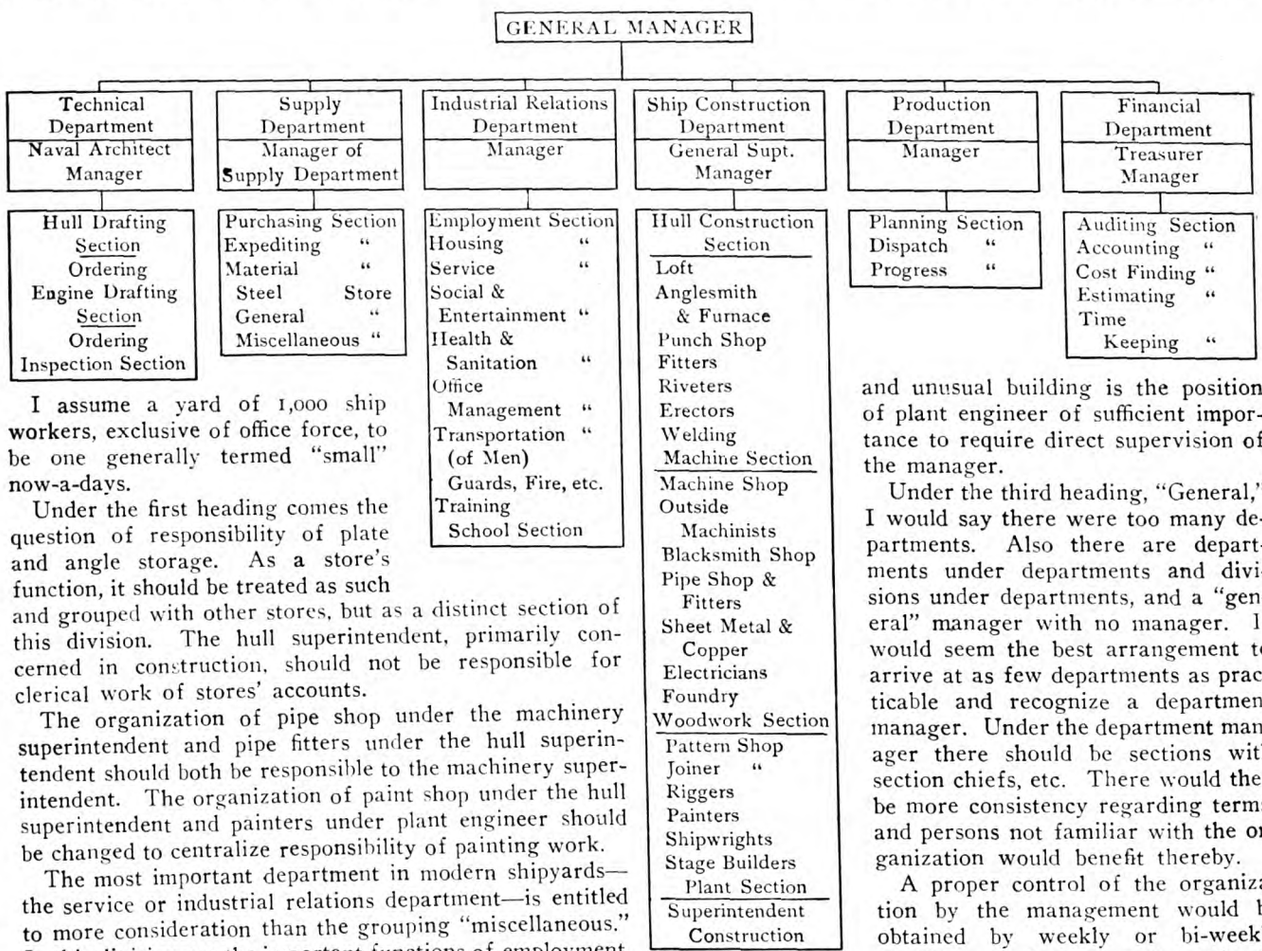
I would like to take up the question of "Effective Arrangement of Departments in Shipyard Organization," described on page 165 of the November issue, by G. F. S. Mann, B. S., under headings as follows:

First—Organization which is wrong in theory and practice.

Second—Changes which are customarily found more satisfactory.

Third—General.

Fourth—Suggested chart embodying the above which would make an organization more effective.



I assume a yard of 1,000 ship workers, exclusive of office force, to be one generally termed "small" now-a-days.

Under the first heading comes the question of responsibility of plate and angle storage. As a store's function, it should be treated as such and grouped with other stores, but as a distinct section of this division. The hull superintendent, primarily concerned in construction, should not be responsible for clerical work of stores' accounts.

The organization of pipe shop under the machinery superintendent and pipe fitters under the hull superintendent should both be responsible to the machinery superintendent. The organization of paint shop under the hull superintendent and painters under plant engineer should be changed to centralize responsibility of painting work.

The most important department in modern shipyards—the service or industrial relations department—is entitled to more consideration than the grouping "miscellaneous." In this division are the important functions of employment, watchmen and dispensary, but the more important ones in view of holding men employed, of housing, social entertainment, health and sanitation, transportation (as it affects facilities used by workmen), advertising, publicity, draft exemptions, absentee section, general office management.

Under this second heading comes the question of the grouping of naval architect and chief engineer. The older yards needed the naval architect as designer, etc., but with our ships already designed his late functions become of less importance, and the manager may now look to him for more responsibility in all matters of a technical nature, i. e., specifications, plans, requisitions for ship material, inspection (applying to accuracy with which plans are carried out).

The necessity of a department responsible to the manager, whose functions are to plan the work to be done at stated times by various departments and show progress on such plans is receiving so much attention in modern business that it cannot safely be omitted from the smallest organization which is concerned with contracts in which time is the essence.

A beneficial change could be made in the organization of the construction departments, so that one general superintendent is responsible to the manager for ship construction. Under this could be a superintendent of hull construction, superintendent of machinery and superintendent of woodwork. With this last the pattern, shipwrights, painters, joiner shops, etc., would be more effective than that shown.

Under this general superintendent would come the plant engineer and the maintenance of plant. Only in extensive and unusual building is the position of plant engineer of sufficient importance to require direct supervision of the manager.

Under the third heading, "General," I would say there were too many departments. Also there are departments under departments and divisions under departments, and a "general" manager with no manager. It would seem the best arrangement to arrive at as few departments as practicable and recognize a department manager. Under the department manager there should be sections with section chiefs, etc. There would then be more consistency regarding terms, and persons not familiar with the organization would benefit thereby.

A proper control of the organization by the management would be obtained by weekly or bi-weekly meetings of departmental heads restricted, as stated, to as few as practicable. The general policies of the company and of the effect on department work would be reviewed, and, with a follow-up on the work it had planned, assistance could be given any lagging department. In connection with this, a weekly meeting of section heads under each department manager, at which the general manager would attend in case of need, should give a very good control of the work in every department in the business.

It will be noted by the organization chart submitted that the departments are so grouped that the work done by each section has a very close relation to that of other sections in the same department. This gives an assurance of continuance of department work and policy with promotion of section heads.

New London, Conn. FREDERICK THORNE WARNER.

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Shipbuilding in the United States in 1918

Three Million Tons of Merchant Ships Completed in First Eleven Months—Rate of Production Rapidly Increasing

SHIPBUILDERS in the United States are now turning out merchant vessels at the rate of over 4,000,000 deadweight tons a year. In addition to this, they are engaged on the most extensive programme of naval construction that has ever been undertaken by the Government. Details of the naval programme must obviously be withheld at the present time, but the main features of the merchant shipbuilding programme have been disclosed by the Shipping Board, and the following shows the progress that has been made in this work.

The output of merchant vessels from American shipyards for the first eleven months of 1918, including the output of the first week in December, amounts to 535 vessels of 3,022,606 deadweight tons. The total output from August, 1917, to December 1, 1918, has amounted to 3,054,460 deadweight tons, divided among the principal districts as shown in Table 1:

TABLE 1.—VESSELS DELIVERED TO THE SHIPPING BOARD FROM AUGUST, 1917, TO DECEMBER 1, 1918

District	Number of Vessels	Deadweight Tonnage
Pacific Coast	211	1,480,385
Atlantic Coast	120	848,790
Great Lakes	192	674,585
Gulf Coast	14	50,700
Total to December 1	537	3,054,460

By the end of 1918 about three and a quarter million deadweight tons of new ships will have been completed and delivered to the Shipping Board. The first million tons of completed ships were delivered in May, the second million in August, and the third million in the first week of December. The best pre-war production record, including only sea-going vessels of more than 1,500 deadweight tons, was in 1916, when 38 vessels of 285,555 tons were built and placed in commission. In the first week in December, therefore, when 138,700 tons were produced, American shipyards completed more than half of the total tonnage built in the record year of 1916, and the output in the first eleven months of 1918 has been more than ten times the tonnage produced by American yards in the best pre-war year.

TABLE 2.—STEEL MERCHANT VESSELS DELIVERED TO THE UNITED STATES SHIPPING BOARD DURING THE FIRST ELEVEN MONTHS OF 1918

Shipyards	Number	Tonnage	Number of Vessels	Deadweight Tonnage
Bethlehem Shipbuilding Corporation, Ltd., South Bethlehem, Pa.				
Union Iron Works, San Francisco, Cal.	17	188,525		
Sparrows Point (Maryland) Plant	7	61,250		
Fore River Plant, Quincy, Mass.	6	58,300		
Harlan & Hollingsworth Plant, Wilmington, Del.	7	31,350		
Samuel L. Moore & Sons Corporation, Elizabethport, N. J.	2	7,000		
			39	346,425
American Shipbuilding Co., Cleveland, Ohio			87	305,450
Skinner & Eddy Corp., Seattle, Wash.			25	220,200
Northwest Steel Co., Portland, Ore.			14	123,200
New York Shipbuilding Corp., Camden, N. J.			15	118,300
Great Lakes Engineering Works, Detroit, Mich.			34	116,200
J. F. Duthie & Co., Seattle, Wash.			12	105,600
Seattle Construction & D. D. Co., Seattle, Wash.			12	93,000
Ames Shipbldg. & Dry Dock Co., Seattle, Wash.			10	88,400
Columbia River Shipbldg. Corp., Portland, Ore.			10	88,000
Moore Shipbuilding Co., Oakland, Cal.			9	84,600
Los Angeles Shipbuilding & Dry Dock Co., Los Angeles Harbor, Cal.			8	70,400
Pusey & Jones Co., Wilmington, Del.			10	61,000
Standard Shipbldg. Co., Shooters Island, N. Y.			7	51,100
Sun Shipbuilding Co., Chester Pa.			5	50,300
Baltimore D. D. & Shipbldg. Co., Baltimore, Md.			7	46,000
Manitowoc Shipbuilding Co., Manitowoc, Wis.			12	41,200
Newport News Shipbuilding & Dry Dock Co., Newport News, Va.			4	40,805
Toledo Shipbuilding Co., Toledo, Ohio			11	35,080
Chester Shipbuilding Co., Chester, Pa.			4	34,500
William Cramp & Sons Ship & Engine Building Co., Philadelphia, Pa.			6	33,797
McDougall-Duluth Co., Duluth, Minn.			9	28,500
Albina Eng. & Mach. Works, Inc., Portland, Ore.			7	25,500
Texas Shipbuilding Co., Bath, Me.			2	19,940
Federal Shipbuilding Co., Newark, N. J.			2	19,200
Long Beach Shipbuilding Co., Long Beach, Cal.			4	18,000
Western Pipe & Steel Co., San Francisco, Cal.			2	17,600
Globe Shipbuilding Co., Superior, Wis.			5	17,500
Saginaw Shipbuilding Co., Saginaw, Mich.			4	14,000
Hanlon D. D. & Shipbldg. Co., Oakland, Cal.			2	11,000
Staten Island Shipbldg. Co., Staten Island, N. Y.			3	10,500

Output from Individual Yards

The output of steel, wood and composite vessels from the principal shipyards for the first eleven months of 1918 is shown in Tables 2, 3 and 4, while Table 5 shows the monthly output (in gross tons) since January, 1918, as recorded by the Bureau of Navigation of the Department of Commerce.

Official Returns from the Bureau of Navigation

According to the official figures of the Bureau of Navigation, during the twelve months ended November 30, 1918, the ships built and officially numbered totaled 1,814 of 2,560,503 gross tons, of which 437 of 1,771,560 gross tons were sea-going steel steamers. Table 6 shows the

TABLE 3.—WOOD VESSELS DELIVERED TO THE UNITED STATES SHIPPING BOARD DURING FIRST ELEVEN MONTHS OF 1918

Shipyards	Number of Vessels	Deadweight Tonnage
Grant Smith-Porter Ship Co., St. Johns, Ore., and Aberdeen, Wash.	20	70,000
Seaborn Shipyards Co., Tacoma, Wash.	7	24,500
Grays Harbor Motorship Corp., Grays Harbor, Wash.	6	24,000
Kruse & Banks Shipbldg. Co., North Bend, Ore.	5	17,500
The Foundation Co., Newark, N. J.	5	17,500
Traylor Shipbldg. Corp., Cornwell Heights, Pa.	4	14,000
Russell Shipbuilding Co., Portland, Me.	3	10,500
Ralph J. Chandler, Los Angeles, Cal.	2	7,000
Fulton Shipbuilding Co., Wilmington, Cal.	2	7,000
Coos Bay Shipbuilding Co., Marshfield, Ore.	2	7,000
Groton Iron Works, Noank, Conn.	2	7,000
Tampa Dock Co., Tampa, Fla.	2	7,000
J. M. Murdoch, Jacksonville, Fla.	2	7,000
Coast Shipbuilding Co., Portland, Ore.	2	7,000
Hammond Lumber Co., Humboldt Bay, Cal.	2	7,000
Meacham & Babcock Shipbldg. Co., Seattle, Wash.	2	7,000
Morey & Thomas, Jacksonville, Fla.	2	7,000
Nilson & Kelez Shipbldg. Corp., Seattle, Wash.	2	7,000
Wilson Shipbuilding Co., Astoria, Ore.	2	7,000
McEachern Ship Co., Astoria, Ore.	2	7,000
Dierks-Blodgett Shipbldg. Co., Pascagoula, Miss.	2	7,000
National Shipbuilding Co., Orange, Tex.	1	4,700
Peninsula Shipbuilding Co., Portland, Ore.	1	4,000
Babare Brothers, Tacoma, Wash.	1	3,500
John H. Fahey, Jacksonville, Fla.	1	3,500
Tacoma Shipbuilding Co., Tacoma, Wash.	1	3,500
Alabama Dry Dock & Shipbldg. Co., Mobile, Ala.	1	3,500
Lone Star Shipbuilding Co., Beaumont, Tex.	1	3,500
G. M. Standifer Construction Corp., Portland, Ore.	1	3,500
Jahncke Shipbuilding Co., Inc., Madisonville, La.	1	3,500
Hodge Shipbuilding Co., Moss Point, Miss.	1	3,500
Beaumont Shipbldg. & D. D. Co., Beaumont, Tex.	1	3,500
L. H. Shattuck, Inc., Portsmouth, N. H.	1	3,500
American Shipbuilding Co., Brunswick, Ga.	1	3,500
Wright Shipyards, Tacoma, Wash.	1	3,500
Lake & Ocean Navigation Co., Sturgeon Bay, Wis.	1	2,500

TABLE 4.—COMPOSITE SHIPS DELIVERED TO UNITED STATES SHIPPING BOARD DURING FIRST ELEVEN MONTHS OF 1918

Shipyards	Number of Vessels	Deadweight Tonnage
Supple & Ballin, Portland, Ore.	4	16,000
Merrill-Stevens Shipbldg. Corp., Jacksonville, Fla.	3	10,500
Mobile Shipbuilding Co., Mobile, Ala.	1	3,500

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TABLE 5.—MONTHLY OUTPUT OF AMERICAN SHIPYARDS FOR FIRST ELEVEN MONTHS OF 1918

Months.	Seagoing.						Non-Seagoing.		Grand Total.	
	Steel.		Wood.		Total.					
	Number.	Gross.	Number.	Gross.	Number.	Gross.	Number.	Gross.	Number.	Gross.
January	12	53,748	6	6,468	18	60,216	39	4,579	57	64,795
February	17	94,242	14	17,874	31	112,116	53	5,485	84	117,601
March	29	115,040	12	20,776	41	135,816	97	11,329	138	147,145
April	31	130,637	15	21,017	46	151,654	119	11,396	165	163,050
May	a40	157,598	13	16,453	53	174,051	132	20,413	185	194,464
June	42	163,034	16	26,985	58	190,019	130	11,406	188	201,425
Total	171	714,299	76	109,573	247	823,872	570	64,608	817	888,480
July	37	146,981	38	72,727	75	219,708	118	b10,223	193	229,931
August	49	191,102	39	91,997	88	283,099	89	12,750	177	295,249
September	46	177,765	54	123,668	100	301,433	70	7,037	170	308,470
October	57	228,203	53	117,165	110	345,368	91	12,164	201	357,532
November	60	227,293	55	121,746	115	349,039	56	c8,621	171	357,660

a Includes 1 cement vessel of 3,427 gross tons. *b* Includes 1 cement vessel of 325 gross tons. *c* Includes 1 cement vessel of 11 gross tons.

TABLE 6.—OUTPUT OF AMERICAN SHIPYARDS FOR TWELVE MONTHS' PERIODS ENDING AT THE CLOSE OF EACH MONTH IN 1918

Twelve Months Ending	Seagoing						Grand Total Including Non-Seagoing.	
	Steel.		Wood.		Total.			
	Number.	Gross.	Number.	Gross.	Number.	Gross.	Number.	Gross.
January	144	607,404	137	211,626	281	819,030	1,657	1,025,496
February	157	682,867	146	222,723	303	905,590	1,669	1,106,093
March	180	759,354	153	238,051	333	997,405	1,670	1,194,127
April	203	845,338	157	236,498	360	1,081,836	1,668	1,278,132
May	232	966,850	151	219,947	383	1,186,797	1,661	1,381,369
June	252	1,031,976	158	215,716	410	1,247,692	1,622	1,430,793
July	275	1,124,066	189	274,330	464	1,398,396	1,610	1,571,572
August	315	1,268,452	214	354,172	529	1,622,624	1,612	1,781,379
September	352	1,411,144	256	465,327	608	1,876,471	1,681	2,013,264
October	396	1,594,927	287	546,613	683	2,141,540	1,760	2,280,111
November	437	1,771,560	331	657,487	768	2,429,047	1,814	2,560,503

output for twelve-months' periods ending at the close of each month of 1918 and illustrates the growth of shipbuilding under the impetus of the war.

Shipping Board Programme

The complete programme of merchant ship construction, as authorized by the United States Shipping Board up to October 15, 1918, is summarized in Tables 7-10.

TABLE 7.—REQUISITIONED SHIPS

Type	Number of Ships	Tonnage
Cargo	311	1,978,362
Tankers	60	580,430
Refrigerators	10	72,900
Colliers	9	70,350
Transports	12	88,750
Total	402	2,790,792

TABLE 8.—CONTRACT SHIPS

Type	Number of Ships	Tonnage
Steel	1,604	10,513,905
Wood and composite	1,034	3,024,000
Concrete	42	298,500
Total	2,680	13,836,405
Foreign construction	34	285,850
Total	2,714	14,122,255

TABLE 9.—SUMMARY OF STEEL SHIPS CONTRACTED FOR

Type	Number of Ships	Tonnage
Cargo	1,296	8,877,605
Tankers	80	737,000
Transports	94	787,000
Hospital	2	20,000
Refrigerators	4	37,500
Tugs	112	.....
Barges	16	54,800
Total	1,604	10,513,905

TABLE 10.—WOOD AND COMPOSITE SHIPS

Type	Number of Ships	Tonnage
Concrete	181	707,500
Hulls	519	1,841,000
Barges	140	359,500
Tugs	162	.....
Composite	32	116,000
Total	1,034	3,024,000

Government Expenditures in Shipyards

Up to September 1, 1918, the Emergency Fleet Corporation had invested or contracted to invest in shipyard plants approximately $150,000,000. Of these investments, the largest were at the Hog Island plant, estimated cost complete, $63,000,000 (£13,000,000), and at the plants of the Submarine Boat Corporation, estimated cost, $17,000,000 (£3,500,000); of the Merchant Shipbuilding Corporation, estimated cost, $11,000,000 (£2,260,000); the New York Shipbuilding Corporation, estimated cost, $16,825,000 (£3,460,000), and the Carolina Shipbuilding Company, estimated cost, $3,000,000 (£615,000).

The Emergency Fleet Corporation has investment interests made or authorized in forty-one shipbuilding plants, the majority of these in connection with contract-built ships. The expenditure of approximately $10,500,000 (£2,150,000) for Scotch boiler plants and for steel fabricating plants has also been authorized.

Growth of the Merchant Marine

As all the ships turned out from American yards in 1918 are destined for operation under the American flag, the American merchant marine has during this period expanded more rapidly than that of any other nation in the world. At the time the United States entered the war the American merchant marine included approximately only 2,750,000 deadweight tons of sea-going vessels of over 1,500 deadweight tons. On September 1, 1918, however, there were under the control of the United States Shipping Board 2,185 sea-going vessels totaling 9,511,915 deadweight tons. Of these, 1,294, totaling 6,596,405 deadweight tons were under the American flag.

Of the total number of ships within the jurisdiction of the Shipping Board at this time, 449 were requisitioned American merchant ships, 100 were enemy vessels seized during the war, 256 were new vessels owned by the Ship-

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ping Board, 31 were old Lake steamers transferred to the Shipping Board, 377 were American merchant ships not yet requisitioned, 81 were Dutch ships requisitioned by the United States Government, and 891 were foreign ships chartered either to the Shipping Board or to American citizens. While only a comparatively small part of this tonnage was provided by the Shipping Board, nevertheless at the rate at which vessels are now being built by American shipyards for the Government's programme it will not be long before something like 10,000,000 gross tons of American-built and American-owned vessels will be added to the merchant fleet.

Expansion of the Shipbuilding Industry

For the production of this tonnage the growth of the American shipbuilding industry has been phenomenal. When the present Shipping Board began its work in August, 1917, there were only 61 shipyards in the United States. Thirty-seven of these, with 162 ways, were equipped for building steel vessels, but about three-quarters of their capacity was taken up by the naval construction programme. In the 24 yards equipped for building wood vessels, there were only 73 shipways.

Contrasted with this condition of hardly more than a year ago, there are now 203 shipyards in the United States with a total of 1,020 shipways, or more than double the total of the shipways in all the rest of the world. The list comprises 77 steel, 117 wood, 2 composite and 7 concrete shipyards. The Clyde district in Scotland, famous for years as the greatest of all shipbuilding centers, is already surpassed by four shipbuilding districts in the United States. Two of these, the Delaware River and Newark Bay districts, are on the Atlantic coast, and the other two, the Oakland Harbor and the Puget Sound districts, are on the Pacific coast. One yard alone in the Delaware district—the Hog Island plant—is equipped to produce more tonnage annually than the output of all the shipyards of the United Kingdom in any pre-war year. The United States, therefore, has taken the lead as a shipbuilding nation. It now has more shipyards, more shipways, more ship workers, more ships under construction and is building more ships every month than any other country, not excepting the United Kingdom, which hitherto was the first shipbuilding power.

In accelerating the construction of ships, such progress has been made that, in spite of the addition of many new yards, the average time consumed from laying the keel to delivery of the ship was reduced from 235.45 days in January to 203.7 days in August. During the year ended August 31, 1918, 566 keels were laid, 358 ships launched, 287 ships of 1,800,000 deadweight tons completed and placed in service, and 9,113,880 deadweight tons of ships have been contracted for.

Steel Ship Production

On September 1, 1917, there were 46 steel shipyards actually building ships for the Emergency Fleet Corporation, and there were 125 ships on the ways of a total deadweight tonnage of 881,072, and 27 ships in the water with a tonnage of 192,790, making a total of 152 ships and 1,073,862 deadweight tons under construction.

On November 1, 1918, there were 76 shipyards in which keels for steel vessels had been laid, and there were 374 vessels of 2,575,004 deadweight tons on the ways and 119 vessels of 798,622 deadweight tons in the water, making a total of 493 vessels and 3,374,616 deadweight tons actually under construction. In other words, there has been an increase of 30 shipyards engaged in building steel ships, and the amount of ship construction being carried on has increased by about 1,850,107 deadweight tons.

Shipyards on the Great Lakes have sent to the Atlantic since the beginning of the war a fleet of cargo vessels comprising 181 steel vessels aggregating 611,935 deadweight tons. The significance of this total will be better understood when it is stated that this exceeds by far the entire output of all the shipyards in the United States for any one of the four pre-war years. In addition to the 181 vessels sent to the seaboard since August, 1917, other vessel construction has been carried out on the Lakes.

Shipbuilding on the Great Lakes

It was a Great Lakes shipyard that turned over the first vessel to the United States Shipping Board. This was a 2,930-ton cargo steamship built by the Toledo Shipbuilding Company. Following this, the first substantial contribution to the transatlantic tonnage from the Lakes was a fleet of 21 steamships with a total deadweight tonnage of 77,400. These vessels ranged from 4,000 to 5,000 deadweight tons capacity, and some of them had to be cut in two to get them through the locks of the Welland Canal to the St. Lawrence River. These were among the first vessels commandeered by the United States Shipping Board, and 19 of them are still plying the seas. They were soon followed by the newly constructed vessels, which, up to November 1, numbered 160 of 534,535 deadweight tons.

The fleet of new steel cargo carriers from the Lakes is made up principally of single-deck vessels about 250 feet long, 40 feet beam, with a minimum draft of about 8 feet, commonly known as the *Frederikstad* type of freighters.

To a Great Lakes shipyard belong the world's record for the rapid construction of a steel cargo steamship. This record was won at the Great Lakes Engineering Works by completing the 3,500-ton cargo steamer *Crawl Keys* 34 days from the laying of the keel. The vessel was launched 17 days after the keel was laid. During the 12 months ended December 1, 1918, the Great Lakes Engineering Works built and delivered to the Shipping Board 34 steel vessels aggregating 122,000 deadweight tons. This output represents the delivery of a completed ship every nine working days of the year.

Shipbuilders on the Great Lakes have been successful in producing a ship of about 4,200 tons deadweight which can be passed through the Welland Canal. Designs were prepared for a vessel of about 6,500 tons deadweight which could be built on the Great Lakes in two sections, to be joined in the St. Lawrence River without the necessity of dry docking by the use of cofferdams. After careful consideration, this design was abandoned for the 4,200-ton size with a view to speeding up production, but, as a sufficient number of ships of the smaller size have now been provided, the future construction of the 6,500-ton vessel on the Lakes is being considered.

Shipyards building steel vessels for the Emergency Fleet Corporation have been asked to assume responsibility for arranging directly with the mills for the delivery of steel, in a general order which was issued under date of December 9, by the vice-president and general manager. This new policy is due to the fact that the supply of steel now promises to be ample and that the Steel Division of the War Industries Board has ceased its activities.

The order will not be put into full effect until February, 1919, because allotments of steel for delivery during January already have been completed. It will be necessary for deliveries of steel thereafter to be made by each shipyard directly with the mills. The Corporation reserves the right to instruct mills to suspend shipments if it is judged that the condition of the steel supply at any shipyard or fabricating plant is, or threatens to become, excessive.

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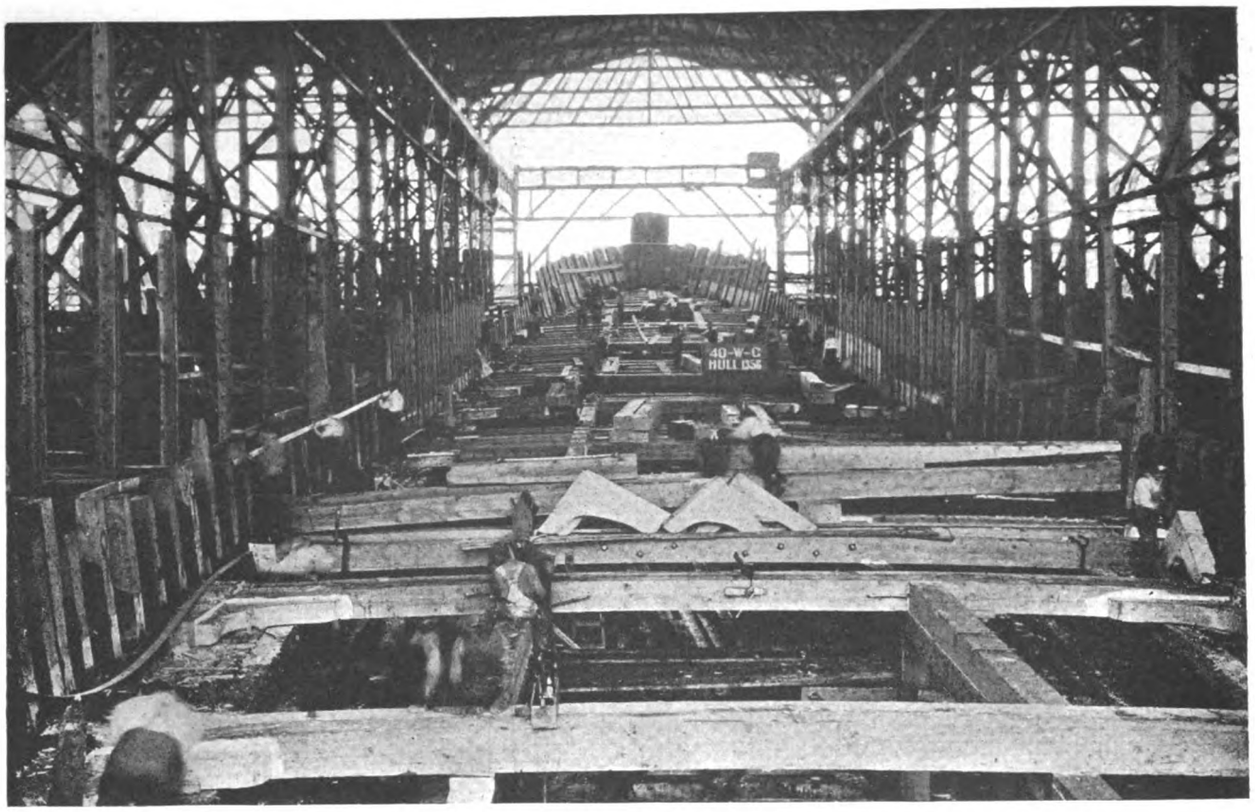

Fig. 1.—Immense Sheds Protect Men in Winter. Temperatures Are Such That Sides Are Not Required

Building Wooden Vessels on the Pacific

Record of Accomplishment—Hough and Ferris Types Give Way to 5,000-Ton Vessel—Wood Vessels Coming Into Their Own

THE history of the revival of wood ship assembling in Oregon and in the Northwest is fraught with interest from the very inception of the movement. Under the impetus resulting from the activities of the Emergency Fleet Corporation, this district has stood out as the leader in wooden shipbuilding in the United States. Those in the section claim the greatest number of hulls afloat and the delivery of the first completed ship. The location was, of course, a decided advantage. The huge fir trees adjacent to the Columbia River are felled, trimmed and rafted upon the river for towing to the mills. In fact, each shipbuilding locality has mills nearby; in a few cases shipyards are actually on the property adjoining the mills.

Nevertheless, the speed with which American shipbuilders have responded to the demand for Yankee tonnage—the Northwest, especially, in the construction of wooden steamers to augment the gigantic fleet which the Government has been assembling through the Emergency Fleet Corporation—has helped to pile up the clouds of defeat which rolled down upon the German horizon.

Oregon Section Pushes Construction

As to the wood plants of the Oregon section—officially designated as District Number 11—they are in their full stride. On February 17, 1918, the first hull, a Hough ship, went overboard; there were sixty-five wooden ships in the water by November 1. Of that number, thirty-three were officially delivered as finished vessels up to November 8. The schedule calls for sixty-three in all to be in commission by December 31, 1918. When October closed seventy-one hulls were yet to be completed.

Fifteen Plants Building Ships

In all, there are fifteen wood ship plants; twelve have been working upon Emergency Fleet Corporation contracts for some time, another is preparing for Government ships after having turned out tonnage on private account, while one has floated eighteen of twenty steam auxiliary schooners for the French Government, and the last has eleven private ships to its credit, not having taken on Federal business yet. And all of the hull work, with a large percentage of the fitting out details, have been taken care of with a total of 15,000 men.

That roughly summarizes the status of wood ship construction in the Oregon district to-day. But it does not tell the story, other than from the standpoint of results. The historical background which made this production possible is another tale.

It was Oregon that led the way in the introduction of large auxiliary schooners of the wood type. The *City of Portland*, a five-master, fitted with semi-Diesel engines to drive twin propellers, was the vanguard. She has circled the globe since her completion two years ago. The precipitation of the European war almost immediately created a call for more tonnage on the Pacific side. It

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was first felt in the loss of vessels owned by the Allies from the trans-Pacific trade, liners and tramps being taken for military necessities. Later American owners began to find their ships sought by agents of the countries at war. In a comparatively short time even steam schooners, the wood carriers so familiar on the Coast, were being negotiated for. The old reliable "fore and aft" schooners, which some authorities had held a few years ago would soon be numbered with "bone yard" relics because of the inroads of steam tonnage, were suddenly most popular. With lumber orders piled high and tonnage limited, the natural result was for vessel owners to turn to a type of ship that could be built at home, of native material and along lines regarded best fitted for the Pacific service.

The St. Helens Shipbuilding Company first built the auxiliary schooner *City of Portland*. Others of the same design were soon on the stocks. Within a year other plants were projected and they were in position to give the American government assistance when, following the declaration of war against Germany, the Emergency Fleet Corporation was formed and included wood vessels in its program. The entrance of the Government into the market had a most stimulating effect upon the building of new plants. Work was carried along with phenomenal speed.

Nine Shipyards Within Street-Car Radius

To-day there are nine wood plants in the Portland zone —that is, within street car radius—and another at St. Helens, 28 miles below Portland. Columbia City, less than two miles from St. Helens, boasts a yard; three more are located at Astoria, just inside the entrance to the Columbia River, and one at Tillamook, on the Oregon coast a short reach from the Columbia. Two more yards are maintained on Coos Bay, Oregon, but, because of geographical location, are included by the Government in the California district—a total of seventeen yards.

The Hough and Ferris designs were first laid down in the yards. Both are of the 3,500-ton type, deadweight. The Hough ship is 288.6 feet overall, 274 feet between perpendiculars, has a beam of 45 feet and molded depth of 28 feet. The Ferris ship is 281.6 feet overall, 268 feet between perpendiculars, with a beam of 46 feet and molded depth of 26 feet. Both are being given a total of 1,400 horsepower, the Hough ship with twin engines and the

Fig. 2.—They Calk Decks With This Machine, the Design of an Oregonian. Two Men Do the Work of Eight Hand Calkers

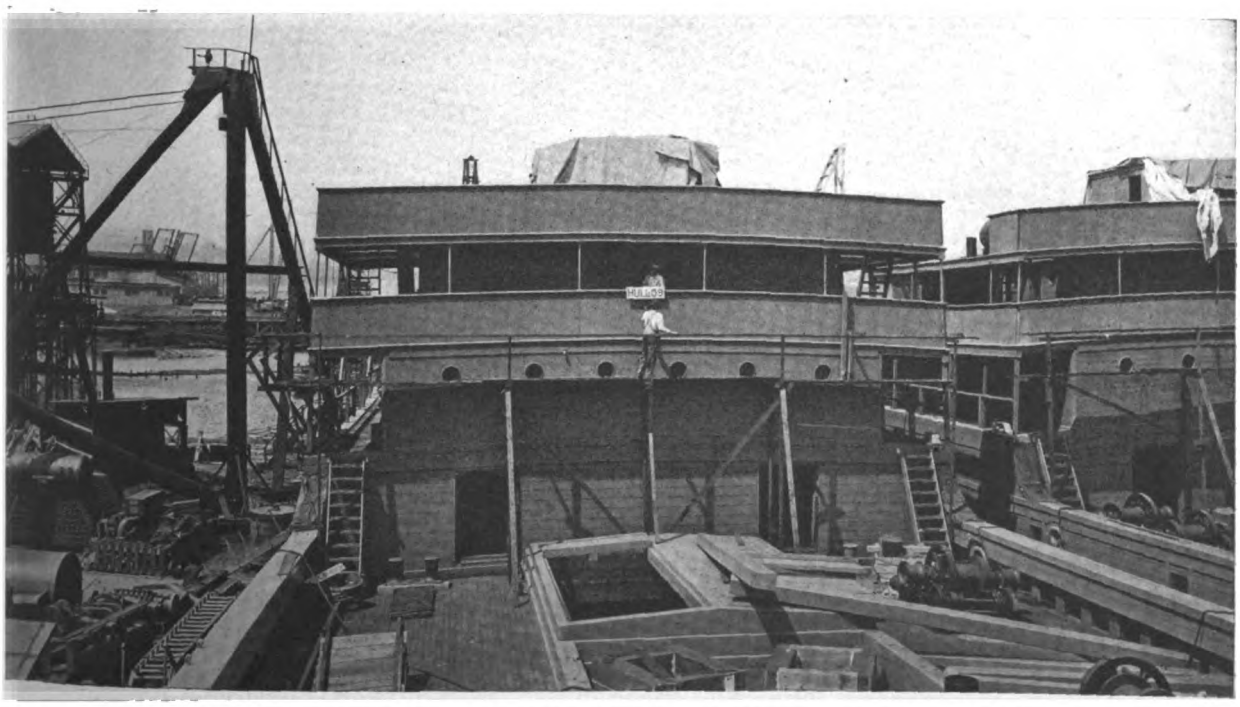

Fig. 3.—Hull 59, Forward, Looking Aft. Here She Is in the Hands of Machinists and Joiners

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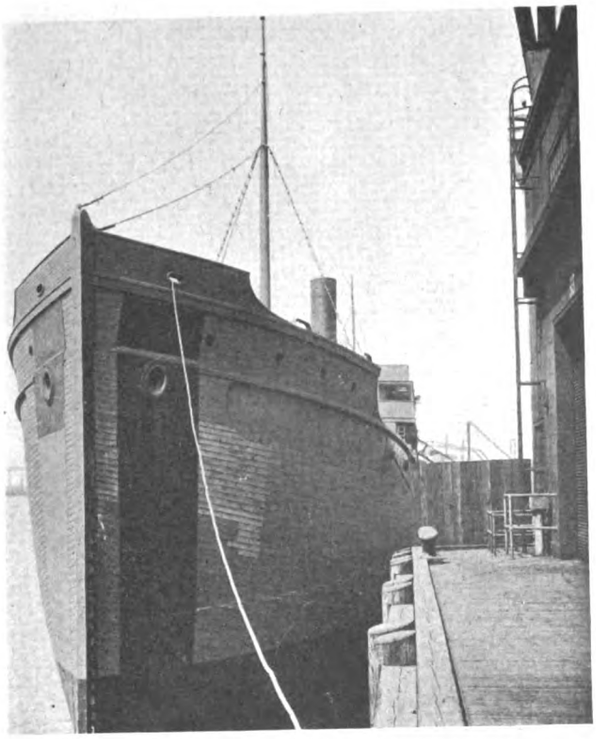

Fig. 4.—Bow View of Hull No. 229. Only a Few Days Before She Moves Down the Harbor to Do Her Share in War Transportation

Ferris with a single main engine. Not since the yards were first started, however, has the Government repeated orders for the Hough ship, apparently having preference for other types.

The development of local designs followed. Fred A. Ballin, of the Supple-Ballin Shipbuilding Corporation, introduced a composite ship with steel topsides; these ships have a deadweight capacity of 4,500 tons. The vessels are 308 feet overall, 286 feet between perpendiculars, with a beam of 43 feet and molded depth of 36 feet, having 1,600 horsepower. The Peninsula Shipbuilding Company is the parent of what is known as the "Peninsula" ship, a distinctive all-wood type with a deadweight of 4,000 tons. This ship calls for a length overall of 282.8 feet, and 267.8 feet between perpendiculars. The beam is 48.8 feet and the molded depth 27 feet. Turbine engines of 1,500 horsepower are installed. This is the only wood ship design, so far as is known, in which turbine engines are used. Trials of the first vessels have proved most satisfactory.

Last of the special plans is a 5,000-ton all-wood steamer, the result of experiences of government officials and the builders, who have foreseen the demand for a larger carrier. The plans and specifications have been approved by Lloyds and the American Bureau of Shipping, and construction has been authorized by Charles Piez, vice-president and general manager of the Emergency Fleet Corporation. The ship will have a length of 344 feet 5 inches overall and 315 feet between perpendiculars, with a beam, molded, of 48 feet, and depth, molded, of 34 feet 6 inches. The vessel has a full shelter deck and two 'tween decks. The material for these ships will be of unusual length, and in some features, such as keel, keelson, stem and stern construction, will call for pieces of large dimensions. For the present, these vessels will be engined with the motive power designed for the 3,500-ton vessels, but ultimately more power is to be provided. These 5,000-ton ships can be laid down at the yards without additional or different equipment and without extension of the building ways.

Wood Ships Stand Up Under Criticism

Wooden ships, not as to specific designs, but in general, have come in for a share of the general criticism of shipbuilding, which is new to this country in its present large proportions, but, through it all, are "standing up." The satisfactory service of many wooden vessels is sufficient refutation. For example, *La Merced,* an auxiliary schooner built on Puget Sound, has made two voyages with wheat, discharging the first cargo at San Francisco in February and the second in August; both cargoes were in good condition. Another steamer, the *Calusa,* of the Hough type, reached New York in September with her cargo in such fine condition that the Control Committee recommended that stores for the army and navy forces be carried from the Atlantic to the Pacific on those vessels. The *Blandon,* also a Hough ship, has been in service four months between Portland and San Francisco, replacing the steamer *Beaver,* a steel combined passenger and freight vessel taken for war purposes. While the company would not have selected an exclusive freight vessel for the run in normal times, she has proven so satisfactory to her master and chief engineer that they have protested against having the vessel sent into the deep-water trade and receiving one of another design in lieu of it. Steamers of the types being built here have developed speeds up to 13.6 knots—that is with coal, for the Government has not permitted fuel oil to be used in either steel or wood ships of the Emergency Fleet coterie since the decision was made to husband all resources for the navy abroad.

These ships were selected to meet just what the title of the big shipbuilding body indicates—an emergency. If details of construction, machinery and other features are not of the best, they will be changed just as army and navy

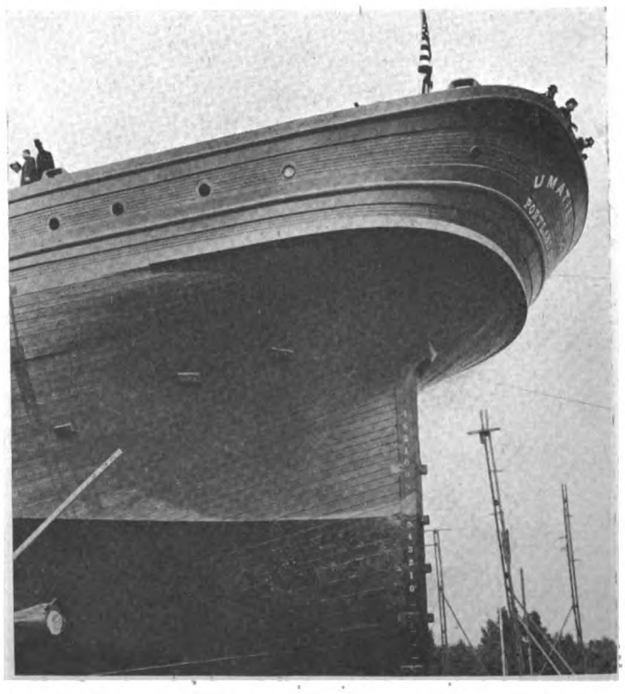

Fig. 5.—Lines of a Ferris Ship Aft, Showing What Can Be Done in Shaping Fir Timber

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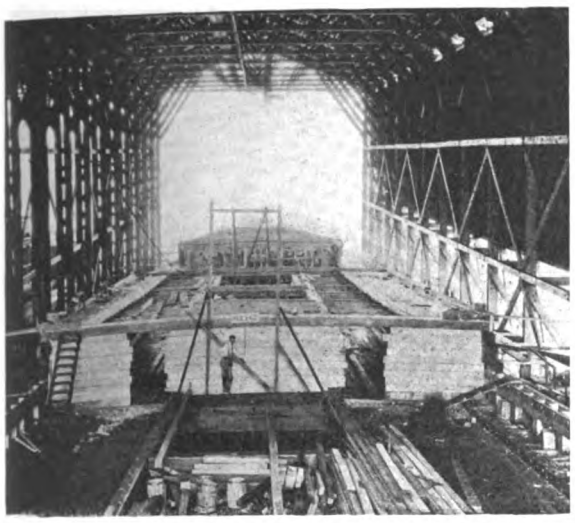

Fig. 6.—With Decks Well Along, the Hull Begins to Look Shipshape

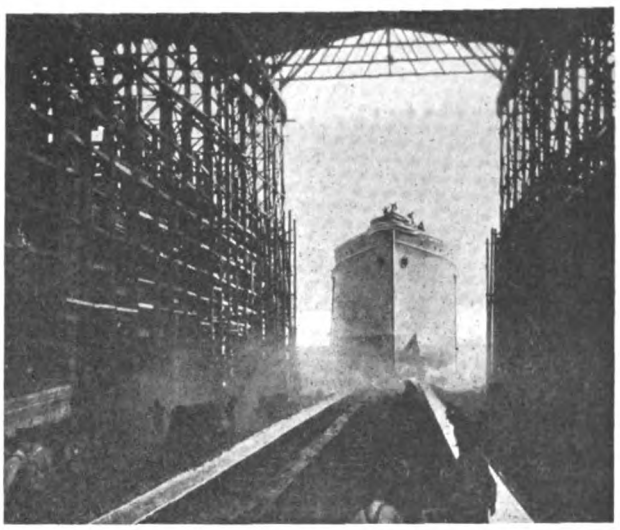

Fig. 7.—Launching of S. S. *Nepolela* to Answer the Hun Challenge

equipment is improved on thorough experience. Much the same arguments that have gone the rounds regarding the wood vessels, might be as aptly applied to some of the steel carriers. Accidents resulting from green crews, however, the "salting" of boilers on the Pacific by the oversight of an engineer whose previous experience was on the Great Lakes, the damaging of winches by inexperienced men, or the permitting of boilers to "go dry"—these can hardly be classed as imperfections in the design of the naval architect.

Wood Ship Here to Stay

Oregon builders do not regard the wood ship as an emergency vessel, however. They were being turned out in this region before the Civil War. In fact, it is on record that seventy-seven years ago the schooner *Star of Oregon* was built by Joseph Gale just across the river from where the Peninsula Shipbuilding Company's present plant stands. Her keel was hewn from a fir timber and her planking was whipsawed. She was in the San Francisco-Hawaiian Island trade for a long period. It was forty-four years ago, on Coos Bay, Oregon, that the full-rigged ship *Western Shore* was built by A. M. Simpson, pioneer shipbuilder and lumberman. The *Western Shore* loaded wheat on her maiden voyage, taking the cargo aboard at San Francisco and delivering it at Liverpool; she was loaded back from there with general cargo. The round voyage was done in 205 days, a feat no metal ship has yet equaled.

Recent tabulations show that Pacific Coast owners control 350 wood steam vessels operating in the Coast and offshore trade. In the fleet 68 are more than 20 years old, 53 are from 20 to 25 years old, 78 from 25 to 30 years, 46 from 30 to 35 years, 42 from 35 to 40 years, 44 from 40 to 45 years, 10 from 45 to 50 years, 5 from 50 to 55 years, and 3 yet running are 61, 65 and 68 years old—a fine record.

Durability Proved

These figures seem to show beyond doubt that there is no question as to durability of the wood ship; but, as with metal ships, they must be given reasonable care. Calking and painting wood ships in the way of maintenance is no more expensive than chipping and painting steel ships to prevent rust from eating the plates.

Stimulated to increased production by the war necessity, which has also served to bring the tried utility of the wooden ship again into prominence, the Oregon shipbuilders feel that the new impetus will continue in momentum during the reconstruction days to come, and provide tonnage to develop Pacific trading facilities to their fullest capacity in the American merchant marine.

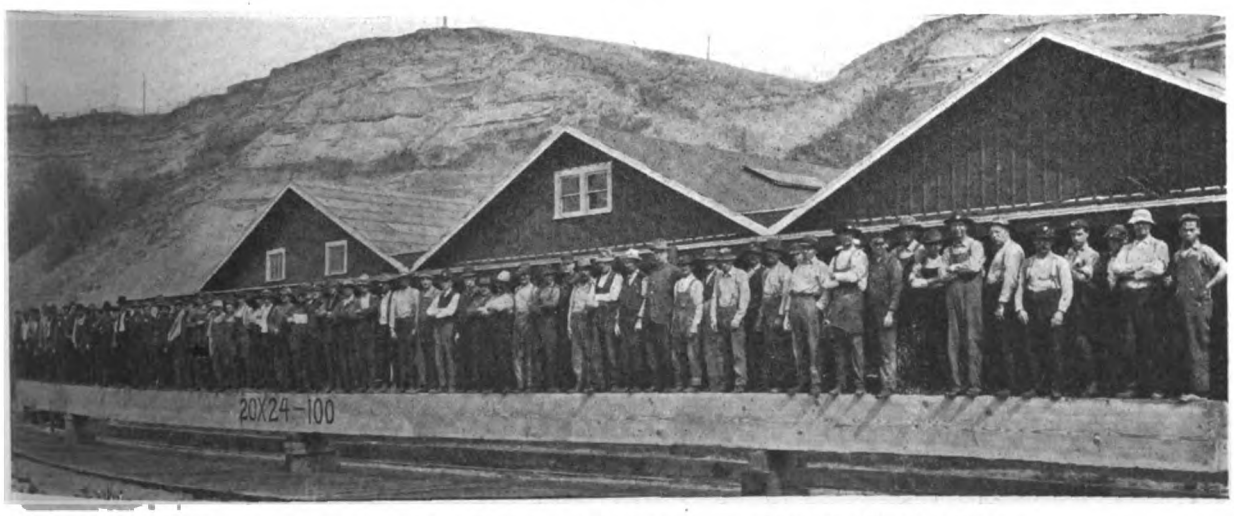

Fig. 8.—Sample of Douglas Fir Timber Used in Construction of Wooden Vessel in Oregon

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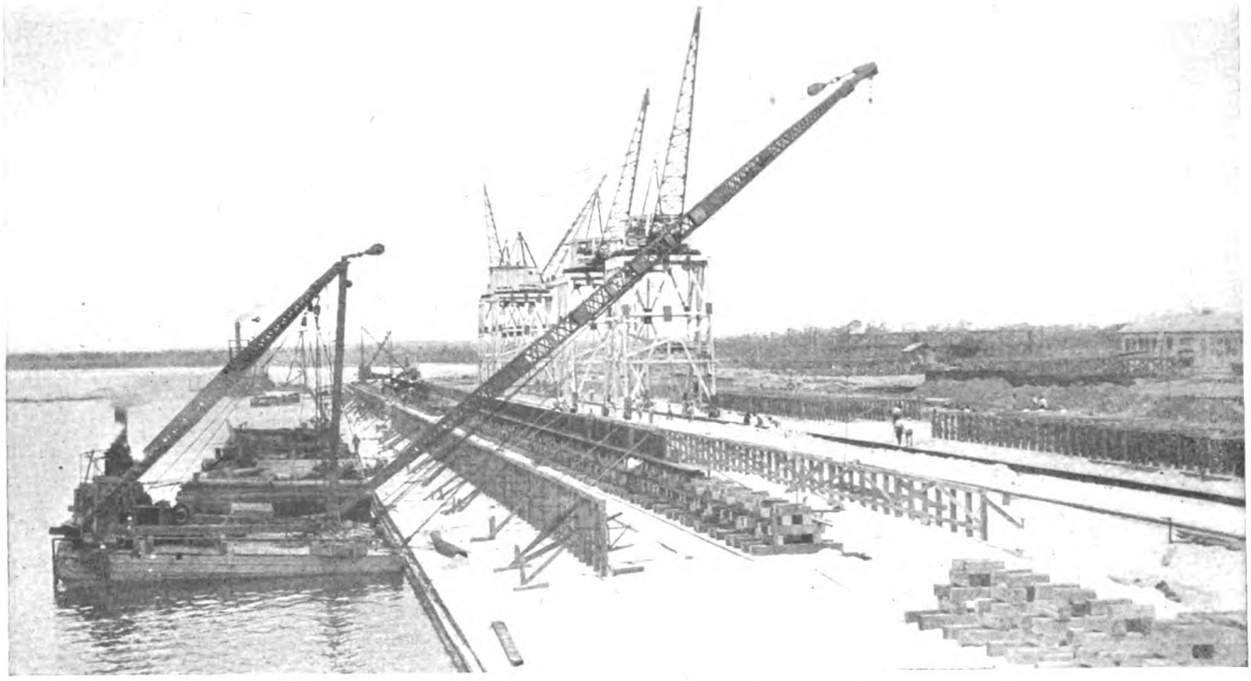

Fig. 1.—General View of Outfitting Dock, Looking West

Shipbuilding at the Pensacola Yards

Well-Constructed Plant for 9,000-Ton Fabricated Steel Ship—Use of Permanent Scaffolding—Powerful Plate Bending Machine

BY JOHN M. SWEENEY*

THE question of establishing at Pensacola berths and equipment for assembling ships at tide water of material fabricated at bridge and structural shops situated near a base of material supply and already in operation, with facilities and tools required for such fabrication, was advised by the writer and considered favorably long in advance of the organization of the Emergency Fleet Corporation. At this time there had just been completed at a structural iron works plant in the Middle West, and under the writer's direction, the fabrication complete of fourteen hulls of light construction. Some suggestions from the experience gained in this fabrication were made to E. Platt Stratton, who incorporated them as a part of his essay on standardized ships prepared under direction of Secretary Redfield, Secretary of Commerce. This paper was used before the Committee of Merchant Marine of the House of Representatives, and later published in pamphlet form and circulated by the Bureau of Commerce.

The first four of these light vessels were set up in 1913 and were of the earliest so fabricated. The American Bridge Company, at their Ambridge plant on the Ohio River, had for some time been building water craft of steel, but confining their work to square ends, declining to undertake any modeled work requiring beveling of parts. They also erected work at their plant, and so in their operation largely adopted the customs of yards where the fabrication is done practically at ship side. In view of the many claims made as to the origin of so-called "fabricated" ships, it may some day be of interest to note these early operations in this field. At the time the vessels mentioned here were undertaken in the industrial shop, the present general manager of the Pensacola Shipbuilding Company was in charge of operation at that plant. Following his later connection with the parent organization of the Pensacola Shipbuilding Company, the project of taking up the fabricating of ocean-going ships inland, and their erection at Pensacola as a desirable point was fairly well canvassed and naturally was expanded into an accomplishment through the demand of the Emergency Fleet Corporation for ships.

The shores of Pensacola Bay offer many excellent spots for shipyard locations, merging as they do into the banks of several bayous, which are really enlargements of the fresh water streams from the water sheds of western Florida and Southern Alabama. The northeast bank of one of these, Bayou Chico, or Little Bayou, was selected for the yard site. A triangular piece of ground of approximately 120 acres, with about one mile of waterfront and entire railroad boundary on the opposite side, and all within the corporate limits of Pensacola, was chosen as best fitted for the general plan of a yard which was to be provided with a continuous-line erecting berth and arranged for side-launching. The water area of Bayou Chico is about 150 acres, and at the present time the erecting berth is some 2,800 feet in length, on which are

* Vice-president and consulting engineer, Pensacola Shipbuilding Company.

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Fig. 2.—Bottom Plating and Vertical Keelson of Ship Number 966, Looking North

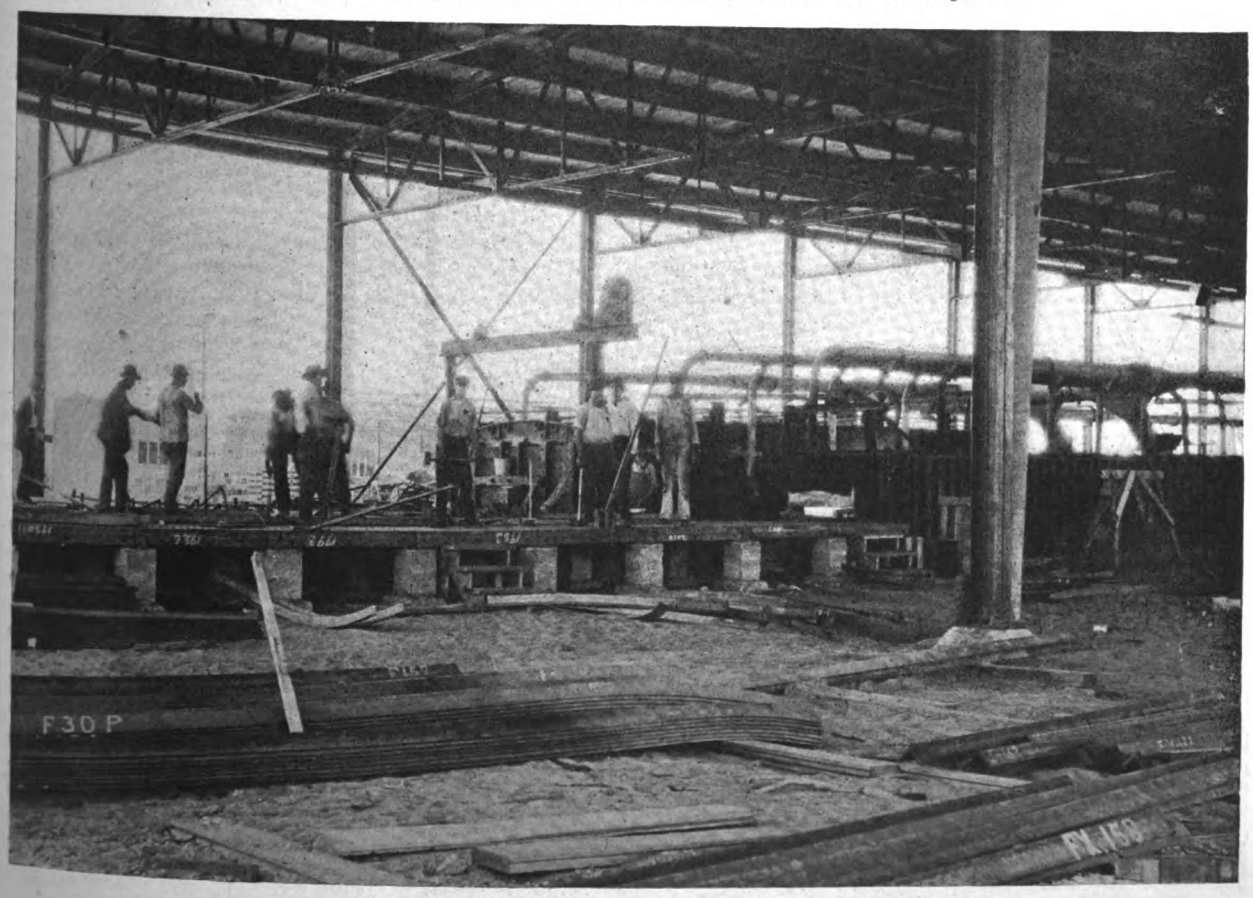

Fig. 3.—Fabricating Shop and Bending Floor, Looking Southwest

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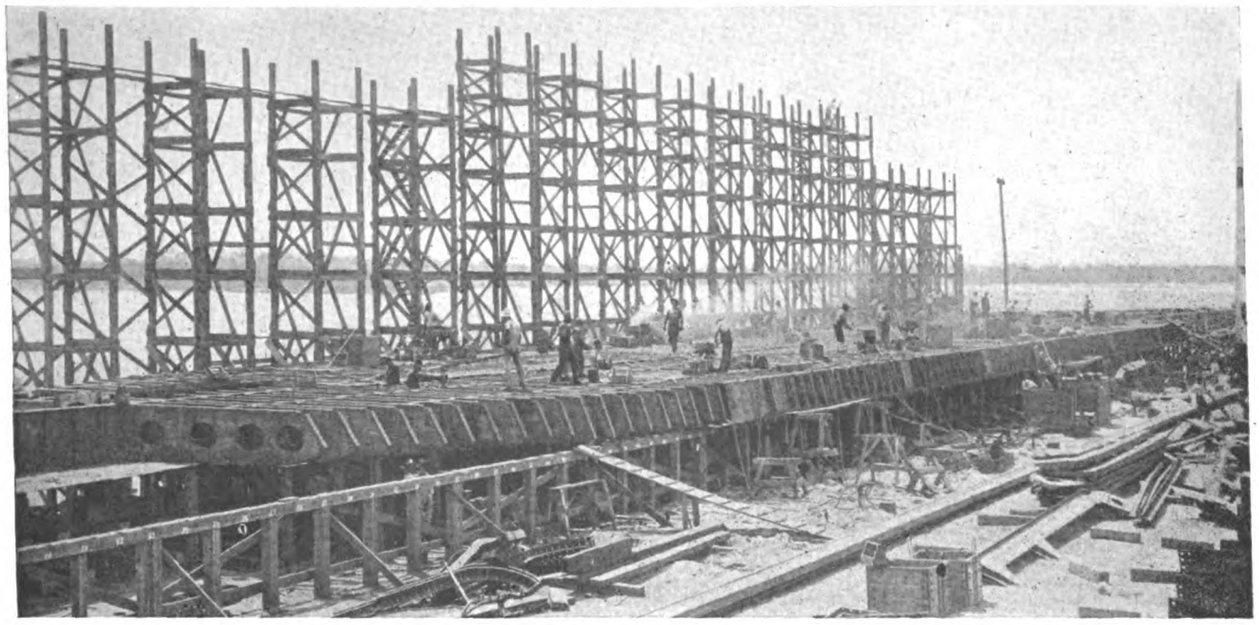

Fig. 4.—Hull Number 965 Showing Arrangement of Staging

in frame, in consecutive lengthwise position, five 9,000-ton steel ships. Beyond this line is a dock line of 1,000 feet for outfitting. On the land side of the berths, gantry tracks extend the entire length, where are traveling at present one gantry for each ship, but, as will be readily seen, with the ability to concentrate any number or all of the gantries at any one objective. On the land side of the gantry tracks there is for each ship a complete binnage for storage of all fabricated material for that ship, ready for transfer by the gantries to position on the blocks. These bins are supplied over a thorough system of ladder trackage connecting all of the yard berths, docks and buildings, and to the main line of the Georgia, Florida & Alabama Railroad.

The normal tide variation is 1.1 feet, one tide in each 24 hours. The general elevation of shipside bins is plus nine, and of fabricating shops plus fifteen.

The first foundation, that of the mold loft, was placed February 24. Operation commenced on the bending and fabricating shop, April 14. Keel blocks were in position ready for laying of the first keel on May 1. Two keels were laid June 21. The entire tract of ground is a strong white sand formation and provides choice conditions for all foundations for blocks and machinery. The berths are continuously piled their entire length in bents on 8-foot centers, the waterfront on 30-inch centers bulkheaded, and sand filled solid behind the bulkheading. The bulkheading is 3-inch yellow pine sheet piling, creosoted to 14 pounds per cubic foot. This method of berth construction has the advantage of providing for any length of ship without change or complication.

Beyond the building berth the dock line continues for 1,000 feet, providing space for fitting out berths, under heavy cranes, for placing boilers and machinery. The continuous building berth plan provides for side-launching only. This method is the one almost universally employed on the Great Lakes and it is the one preferred and favored by all engineers who have had experience with both end and side launching. They consider that it offers less chance of accident, creates less harmful strains and necessitates less cost for preparation.

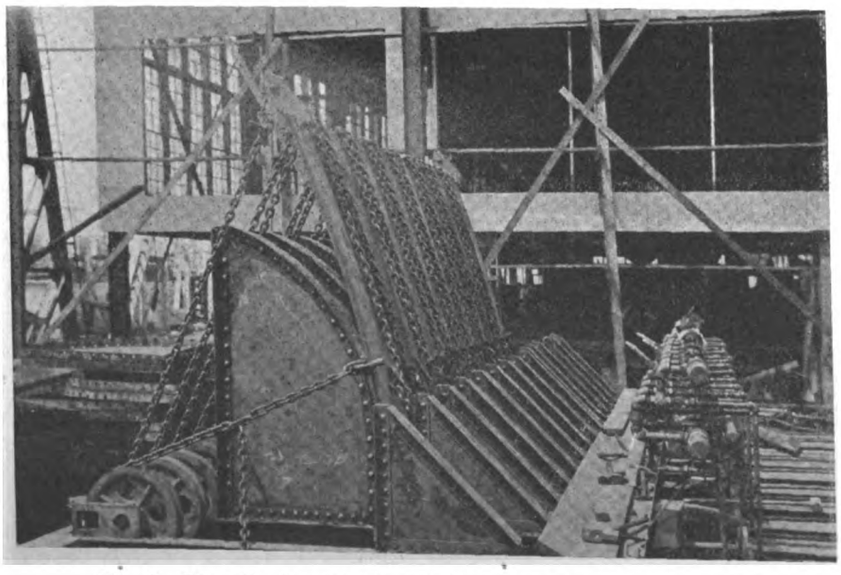

Fig. 5.—Plate Bending Machine Showing Plate Ready to Be Formed

One new yard on the Delaware River has been constructed for side launching and has already had several successful launchings. The first impression of the layman, and indeed often of engineers, is against the advisability of side-launching because of an impression that the ship is dropped on the water. This, however, is not the effect obtained. It may be more aptly likened to the skipping of a stone so thrown on the surface. Many ships approaching 600 feet in length are constantly launched by this method at the yards on our Great Lakes, and, so far as the record shows, without failure or injury.

Referring to the general layout of

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the Pensacola Shipbuilding plant, in the track layout and location of buildings one of the first considerations was to plan that the flow of material should be as continuous in one direction as possible. Some incentive to this arrangement was found in a realization of the fact that materials arriving from the Chicago, Pittsburgh or Alabama districts were started from some 600 to 900 feet elevation above sea level and rolled down hill to the Pensacola yard. The most natural thing was to keep them on a down hill pull through the shops and yards to the erection blocks.

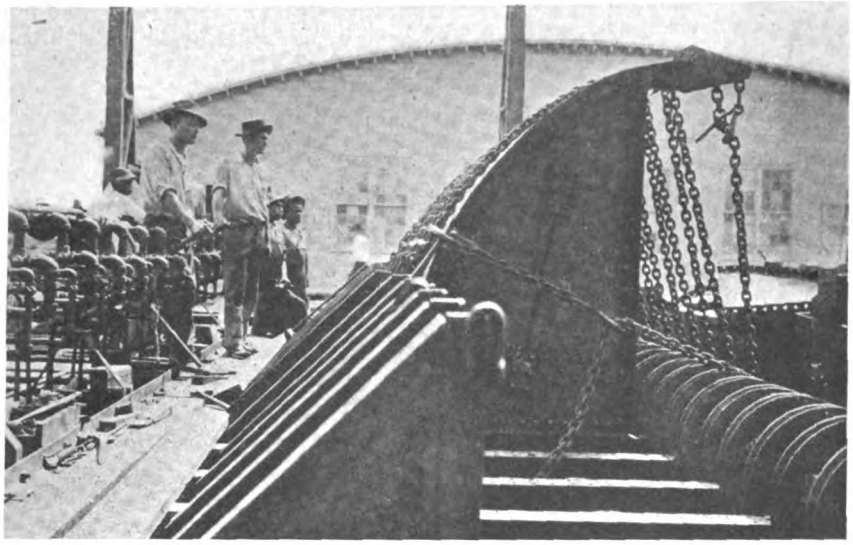

Fig. 6.—Plate Bending Machine Showing Plate Formed

Another actuating factor was the conviction that plenty of trackage and yard room formed a sort of "safety first" towards efficient and low cost ship construction. How well this has been met will be appreciated by every engineer who studies these conditions. The relief from the usual congested and poorly arranged shipyard was patent at every turn. Of course, most of our shipyards have expanded from smaller units, and therefore it has been impossible to avoid objectionable duplication of movement in handling. However, no yard recently built from a virgin location can more favorably compare in percentage of superior attributes than the yard in question. It merits the expressed opinion of an experienced engineer, who, on leaving the plant recently, said: "This is not only the best arranged and best balanced plant, but also it is the most picturesque of any I have seen or known of."

Mention of a few details of this construction will demonstrate the care with which it has been planned. The ladder track connections enable the placing of cars of material in position for unloading in the bins, warehouse, under crane runway, or in any shop or building with a minimum of interference with car movements within the yard. About six miles of trackage is laid within the yard limits, and in the history of the operation of this plant (so far) car demurrage cost is unknown.

The method of scaffolding construction is of a form more permanent than the usual single-bent plan. Here scaffold towers 6 feet by 8 feet and various suitable heights are used. Each tower is self-contained and anchored at the foot. They are placed generally with ten feet of space between them. The stage plank may be easily slipped through, leaving a clear space between the towers. This method avoids the necessity of hoisting material over the top of the staging. When launching, towers are easily lifted away, rested on end and quickly replaced for the next ship.

The gatehouses for employment and photographic headquarters, police department, hospital and inspectors' offices, garage, main administration office, engineering office and clock houses are of usual scope and plan, but are all of single-story construction.

The mold loft is a ground floor building 75 feet in width, clear span. The truss construction, of wood, is that known as lattice and requires no vertical bolting. This truss has been very satisfactory. Its general appearance is seen in the interior view of the loft. The same truss construction is used in the wood mill and cafeteria buildings. The location of the mold loft enables the ready reach of plates and shapes in stock under the receiving overhead crane runway or yard. Under this crane is located a plate-bending machine for cold plates, which is doing very satisfactory work. It was especially designed and developed from a crude machine put in use at the

Fig. 7.—Interior of Mold Loft, Looking East

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fabricating plant and on the marine work before described.

The forge and fabricating shops, each 65 feet wide by 300 feet long, are adjoining. The forge shop contains, in order of progress of the material in fabrication, bending floors and furnaces, rivet machines and furnaces, steam and power hammers, furnaces and small fires, bolt header and bolt-threading machinery.

The fabricating shop is well supplied with the usual fabricating tools, riveters and furnaces. Oil fuel is used for furnace heating and is stored in appropriate tankage under ground and its distribution automatically controlled.

The machine shop is provided with new and modern tools, especially for heavy work. They consist of lathes, planers, slotter, large floor boring machine, radial drill, and also a complete small tool equipment. Electric power distribution is used throughout. The power plant, of 1,800 horsepower normal, has three watertube coal-burning boilers, direct current and alternating current generators, and modern air compressors of 5,000 cubic feet of air capacity at 100 pounds pressure. The air distributing pipe lines throughout the building berths and for all air power operations are extra large and provided with sump tanks and blow off over the entire system.

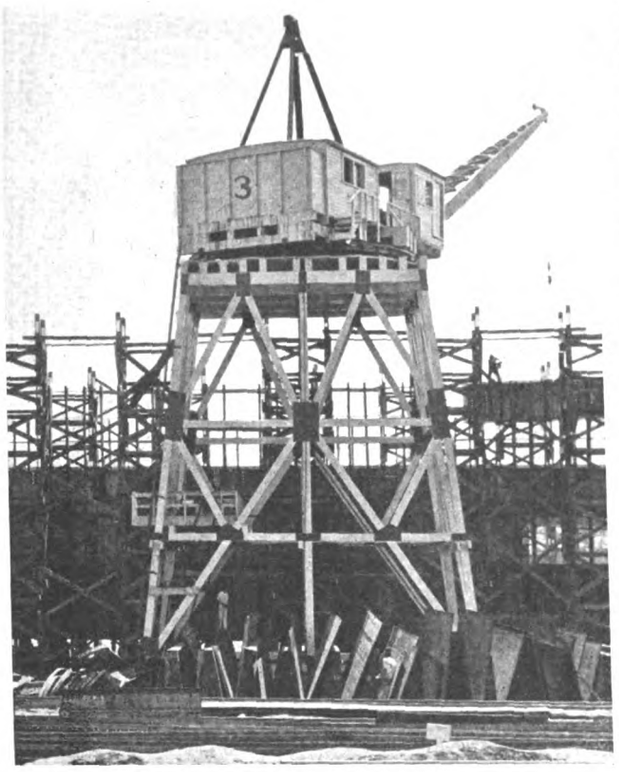

Fig. 8.—Broadside View of Hull Number 966

An eight-ton refrigerating plant is installed, and complete telephone intercommunication to departments and erection berths is in full operation. This plant promises to be in the "survival of the fittest" class for competitive construction of ships after the war. The conditions are ideal for ship construction, and not only provide advantages equal to those of southern California but also are much superior in the item of available labor and closer connections with the market for supply of all required materials.

Pensacola, with its favored water terminals, superior anchorages and abundant supply of low cost bituminous coal, must be a prominent factor in the marine expansion which the United States is now entering upon.

Geared Drive

BY N. W. AKIMOFF*

TO an impartial observer, one of the most puzzling things about the installation of reduction gears on board ship is the attitude of the engineer who is investigating, designing or installing the gear. During the past twenty years all efforts have been directed toward the purely kinematical side of the problem; that is, how to design and cut the gear teeth, how to provide for the distortion of the pinion relative to the gear, and how to overcome the difficulties due to the length of face of the gears, etc. In this direction a great deal of very creditable work has been done and many improvements of considerable ingenuity have been introduced, but, in view of all this, is it not well now to begin to realize that another phase of the problem, hitherto neglected, exists, and that is the dynamics of the geared drive problem?

In the geared drive the link between the point of application of the power to the gear and the point where the power is delivered to the water by the propeller possesses a mass of its own which is not only considerable but enormous! Take, for instance, the case of a shaft 100 feet long weighing 20 tons, whose cross section has a radius of gyration of .4 foot. On each end of this shaft is a heavy rotor. At one end it is the gear weighing 5 tons and at the other end the propeller weighing 10 tons. Let the radii of gyration of each be 4 feet. These round figures are merely assumed, although in actual practice the combination may be even worse.

With a system such as this, the mere fact that 10,000 horsepower is put into the gear for transmission to the propeller at the other end becomes insignificant if consideration is given to what is going on in the connecting system itself; that is, in the shaft-plus-gear-plus-propeller. To calculate results in connection with such a drive, and at the same time disregard the connecting system, is a waste of time. All the bearing pressures and rubbing unit stresses and so-called factors of safety are devoid of any practical meaning. For this reason it is childish to explain the failure of geared installations by such excuses as misalinement or lack of uniformity in the heat treatment of the gears, etc. Whether these are the true reasons for the failure or not is a matter of only secondary interest. The main problem is to find out first of all whether or not the system has been so designed that it can reasonably be expected to stand the work at all.

What should be realized in investigating the problem is the fact that the connecting system (that is, the shaft-plus-gear-plus-propeller) has a period of torsional vibration of its own and also possibly an overtone or two of some consequence. By torsional vibration is meant the alternate angular motion of the shaft cross sections relative to each other, the axis remaining straight, as in a torsional pendulum. It has a definite fundamental frequency, also harmonics and overtones like other elastic vibrations. As far as the slow speed reciprocating engine drive is concerned, this torsional vibration has long ago been definitely established by Frahm and others, in Europe, and more recently checked by the United States Navy Department under the able supervision of Naval Constructor William McEntee, U. S. N. But when it comes to a high-speed drive, no systematic investigation has so far been carried out.

In the case of a three-bladed propeller, such a system of

* Consulting engineer, Philadelphia, Pa.

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drive receives from the outside three impulses per revolution with which to set up a forced torsional vibration of the frequency $3n$ per minute. If the shaft were perfectly rigid or very short, this would not matter so much, as it is not the impulses themselves which are transmitted to the teeth that are of interest, but if the frequency $3n$ is anywhere near that of the natural free frequency of the connecting system (that is, of the shaft-plus-gear-plus-propeller), then the blows on the teeth will increase in a proportion that will positively stagger anyone unfamiliar with the details of the phenomenon known as synchronism.

Just how heavy the blows will be is a very difficult question to answer, but it is not absolutely necessary to consider the problem from that angle. All that we need to determine definitely is the speed at which trouble will occur, so that either this speed may be avoided, or, if for some reason this speed must be maintained, means can be found by which the torsional vibration may be killed. Lanchester, the great English scientist, accomplished this result in the case of the automobile engine, so why cannot someone else do the same thing in some other manner for a geared drive?

To put matters into concrete shape, the following investigations must be made on a large scale by both the Navy Department and manufacturers:

1. Various formulae must be carefully checked by accurate experiments, giving the frequency of torsional vibration of a system consisting of a long shaft with a heavy mass on each end, but not constrained in any part of its length.

2. The fact must be established that this torsional frequency is independent of whether the shaft is at rest or is actually rotating. It will probably be easy to demonstrate that such is actually the case; then further experiments would be greatly simplified.

3. As the theoretical determination of the actual amplitudes of oscillation is a difficult matter, the limits of speed variation within which we might consider synchronism as practically taking place should at least be found.

4. The limitations, if any, prohibiting the use of a suitably designed friction clutch should be found. The friction clutch, the writer believes, is the most effective as well as the most natural means that can be used in wiping out the effect of torsional vibrations. If such a device can be used at all, the most advantageous location for it should be investigated.

5. All other means by which the torsional vibrations can be damped out should be investigated. It is not unlikely that several methods for doing this can be found in addition to Mr. Lanchester's excellent idea, which, to the best of the writer's knowledge, is patented.

The above are merely a few practical ideas which suggest themselves to the writer every time he hears of the failure of a geared turbine installation. A few theoretical considerations will appear elsewhere shortly.

Shipping Large Marine Boilers*

Herewith is presented an interesting photograph of one of thirty large marine boilers, 14½ feet diameter by 11 feet 2 inches in length, built by the Kingsford Foundry & Machine Works, which are being transported by rail for installation in fifteen vessels building at various points on the lakes. Up to very recently it was impossible to ship boilers over 11 feet in diameter from Oswego, N. Y., where the Kingsford Foundry is located, except by canal. The special car shown in this illustration, however, makes it possible to transport boilers of the dimensions stated. These boilers weigh about 91,000 pounds each; two are carried in each 3,500-ton ship. The car shown is built so that the bottom of the I-beams are only one foot clear of the rail. This allowance is necessary to get clearance under bridges and tunnels. In some instances, in fact, the boilers have clearance of only one inch, and must therefore be loaded very carefully and centrally.

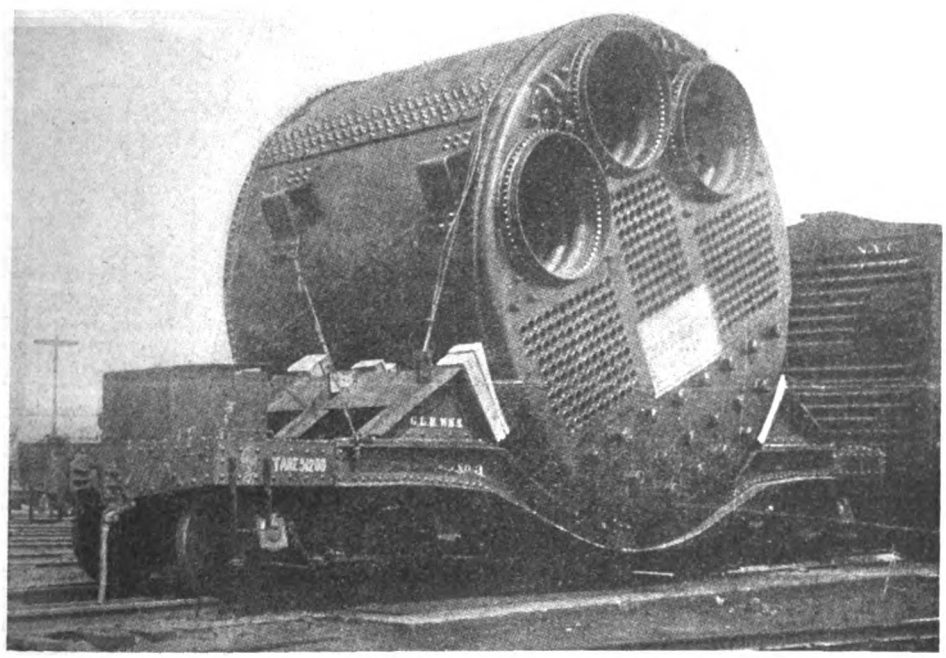

Fig. 1.—Special Flat Car for Shipping Scotch Boilers

* The *Marine Journal*.

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Best Fore-and-Aft Position of Parallel Middle Body in Single-Screw Cargo Ship*

Effect of Variation of Position of Parallel Middle Body on Shaft Horsepower, Propulsive Coefficient and Propeller Revolutions

BY NAVAL CONSTRUCTOR WILLIAM MC ENTEE, U. S. N.

PREVIOUS experiments made at the U. S. Experimental Model Basin indicate† that for slow ships of full lines, such as are used for the ordinary single-screw cargo ship, it is desirable to use a certain amount of parallel middle body. In those experiments the different models used had varying lengths of parallel middle body distributed equally forward and abaft the midship section. The present investigation had for its object the determination of the best fore and aft position for the parallel part of the ship, and the investigation of the effect of this variation on the shaft horsepower, propulsive coefficient, and wake and thrust deduction factors.

Four 20-foot models were made corresponding to ships of 400 feet length between perpendiculars and of 57.3 feet beam, 26 feet draft, and 13,137 tons displacement when fully loaded. A longitudinal or prismatic coefficient of 0.788 was chosen as representing about the present practice in cargo carriers of this type. A constant length of the parallel middle body was taken equal to 33 percent of the ship's length. This percentage was found in the investigations referred to above to give about the minimum residuary resistance for the speeds attained in practice for ships of this type.

In Fig. 1 are shown the lines of model 2,023, which were used as the parent form. In Fig. 2 are shown the curves of sectional area for the four models and the parent form. Model 2,132 was made very full at the entrance, with a fine run. Model 2,135 was made relatively very fine at the entrance and full in the run. Models 2,133 and 2,134 were intermediate between the two extreme models. The model with the very full bow and that with the very full stern were purposely made of an extreme type beyond anything that might be expected to be used, in order to give a wide scope to the investigation and to insure that the limiting conditions as regards power should be obtained at either extreme.

In the four models the middle section of the parallel middle body—that is to say, the section which divided the parallel middle body into two equal portions—was placed at varying distances from the forward perpendicular, amounting to 31.3, 38.5, 53.4 and 60.5 percent of the length of the ship, respectively.

The models were carefully made and all were fitted with the same cast stern frame, which included the stern bearing for the propeller shaft. The stern frame had the rudder cast with it. The whole frame and rudder was fitted to each of the four models before the self-propulsion experiments were undertaken, and, together with the propeller shaft, propeller and dynamometer, were transferred from one model to the other as the experiments with each model were completed.

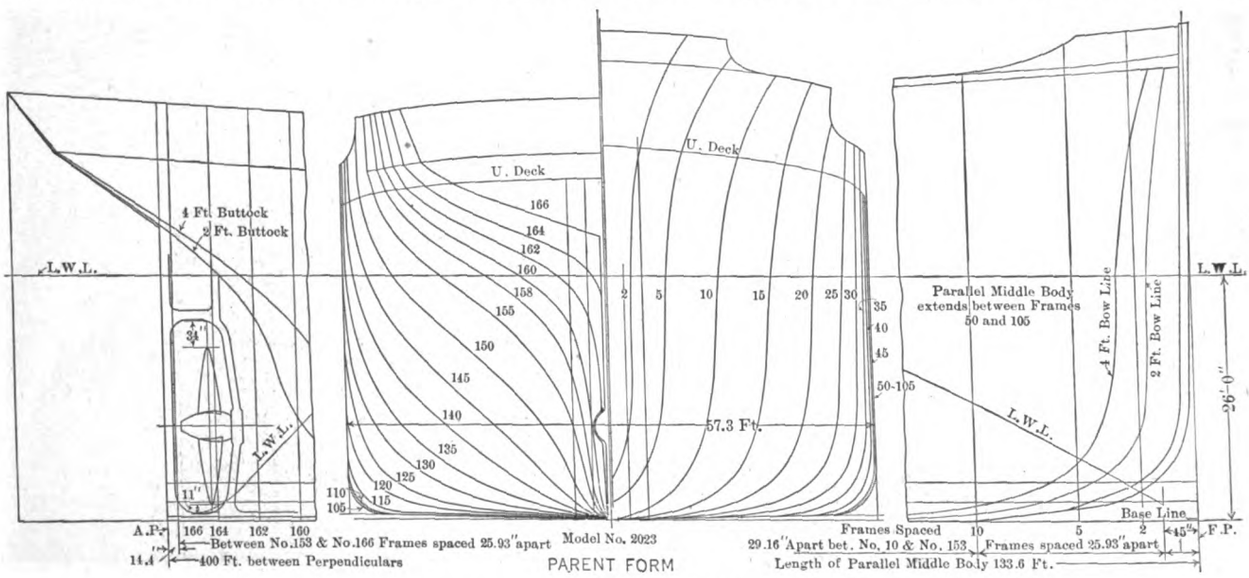

Fig. 1.—Showing Lines of Model 2,023

The dynamometer consisted of a small direct-current motor, the armature shaft of which was directly connected with the propeller shaft by means of a flexible coupling. The armature shaft was free to float fore and aft in its bearings about 7/16 inch in an axial direction. The armature shaft was connected to a calibrated spring by means of a thrust bearing, so that the axial displacement of the armature shaft gave a measurement of the propeller thrusts. Similarly, the frame of the motor was mounted so as to rotate in independent bearings. The torque developed by the motor acted against a calibrated spring so that the deflection of the spring indicated the

* Paper read before the twenty-sixth general meeting of the Society of Naval Architects and Marine Engineers, Philadelphia, Pa., November 15, 1918.

† Speed and Power of Ships, by D. W. Taylor.

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torque of the motor. In addition to this there were suitable means provided for measuring the revolutions of the shaft.

The order of procedure in making the tests was as follows: The shaft and dynamometer were carefully lined up and the whole run for a sufficient time to warm up the bearings and reduce the bearing friction as much as possible. Owing to the fact that the dynamometer was placed very close to the stern, but a short length of propeller shafting was necessary, and this was supported by two self-alining bearings, one at the stern bearing and the other at the forward end of the stern tube. With the propeller shaft in place and everything working freely, the model was towed in the Model Basin beneath the towing carriage at several different speeds, and the propeller shaft, without propeller, run at the range of revolutions to be covered in the course of the experiments. The propeller was then fitted to the shaft and cards for torque and thrust and revolutions per minute were taken with the model self-propelled at different speeds.

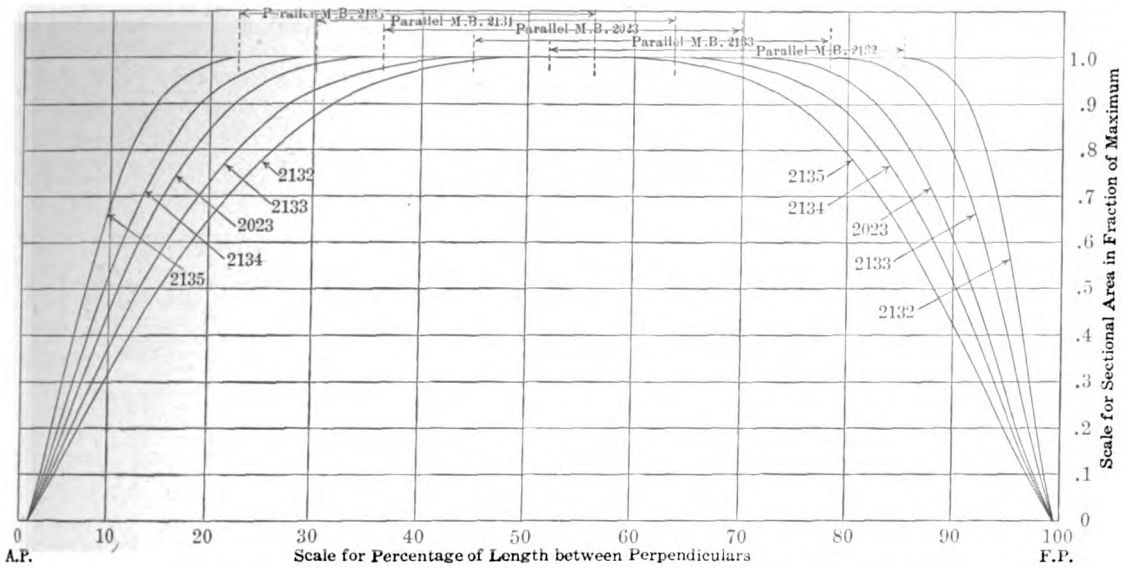

Fig. 2.—Showing Curves of Sectional Area for Four Models and the Parent Form

METHOD OF MAKING TESTS

In these tests the model was guided by two plates about 10 inches in width placed at either end of the model, so as to steer it in a straight course. The guide plates floated between the guiding points attached to the carriage but the towing carriage did not exercise any force on the model in a fore-and-aft direction.

Starting at low speeds corresponding to about 5 knots for the ship, the towing carriage was adjusted to run at a uniform speed. The rheostat controlling the speed of the propeller dyanmometer was then adjusted so that the thrust of the propeller would just keep the model running as fast as the towing carriage, without striking the stops, which were placed at an interval of 6 inches. Thus, starting with the model in the mid position, it was free to gain or lose a distance of 3 inches as compared with the towing carriage before striking either stop. When the propeller was running at the proper speed to keep the model up with the towing carriage the record of thrust, torque and revolutions per minute was taken. If, in the course of the run, the model struck either stop on the carriage the run was discarded and another run made.

Having obtained the desired data at the lowest speed, the carriage speed was increased for subsequent runs and similar data taken at higher speeds. The range covered corresponded to speeds of 5 to 12½ knots for the ship. About forty different runs were made with each model, giving a corresponding number of points for plotting the torque, thrust and revolutions per minute curves.

The armature of the propeller dynamometer was especially designed to reduce to a minimum the amount of magnetic thrust. This thrust increased with the torque and amounted to 0.17 pound when the armature was displaced 7/16 inch and the torque delivered to the shaft was 16 pound-inches. Neglecting this at higher powers would have caused an error in thrust measurements of about 1.4 percent, but would not have caused any error in the power measurements. However, this magnetic thrust was separately calibrated, and corrections for it were made in working up the results of the experiments.

It is interesting to note that experiments of this kind with a very heavy model, in this case a displacement of 3,774 pounds, afford a very sensitive means of checking the uniformity of speed of the towing carriage. If the towing carriage itself were not very carefully adjusted, so as to eliminate slight variations in power required to drive it, owing to variations in the level of the tracks or uneven friction of the driving wheels or guide wheels, the resulting small accelerations and retardations of the carriage were made very apparent. As the model, driven by its own propeller, when supplied with a constant voltage, ran at very uniform speeds, it was possible to see the towing carriage gaining or losing distance of a few inches in five or ten seconds, as slight inequalities of speed due to small variations in the resistance of the driving mechanism developed. In order to conduct self-propulsion experiments successfully with the method followed, it was necessary to have the towing carriage running in excellent condition.

Immediately after completion of the self-propulsion tests on the model the propeller was removed and the runs to obtain the shaft friction and the thrust without propeller was running at the proper speed to keep the with the resistance dynamometer on the towing carriage and the usual model resistance data taken. This insured that the conditions of test both for self-propulsion and for the resistance of the model would be uniform as regards conditions of the model, temperature of water, etc. Experiments on the four models were run on succeeding days.

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and the springs of the propeller dynamometer were calibrated both before and after the tests.

In Fig. 3 is shown one of the dynamometer cards taken for a model running at a speed corresponding to about 10½ knots for the ship. It will be noted that the deflection of the torque spring for this condition was 2.47 inches, for the thrust spring 2.24 inches, and the interval over which the revolutions were measured was 1.78 inches. With a little practice it was possible to read both the thrust and the torque deflections within 1/100 inch. The revolutions could be read to an accuracy of less than one-half of one percent. Considering that the data taken are plotted and the whole averaged by means of faired curves, it is estimated that the results obtained as regards the three elements measured are correct within one percent.

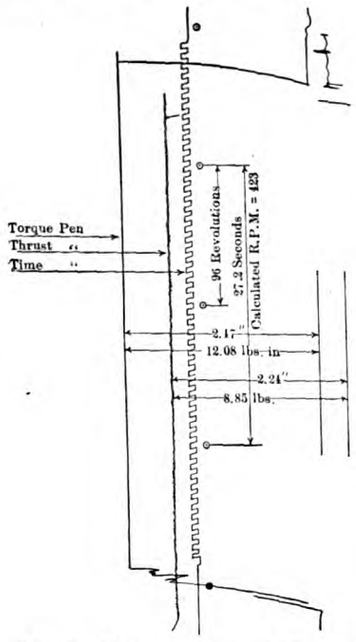

Fig. 3.—Dynamometer Card Showing Propeller Thrust, Torque, and Revolutions per Minute

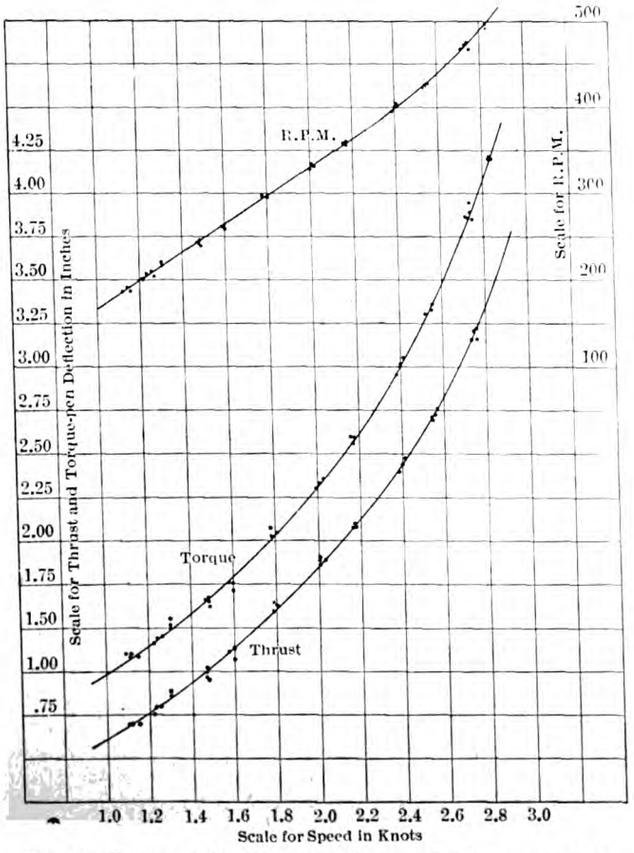

Fig. 4.—Curves of Dynamometer Thrust and Torque-pen Deflections and Propeller Revolutions per Minute. Model 2.133

In Fig. 4 are shown the actual observations of the torque and thrust pen deflections, and the revolutions per minute of the propeller shaft plotted on speed of the model, the latter being measured by the speed of the towing carriage in the same manner as in the ordinary resistance tests.

The following are the dimensions of the propeller used in the experiments and also the dimensions expanded to the ship scale:

	Model	Ship
Diameter	10.125 inches	16 feet 7 inches
Pitch	9.0 inches	14 feet 9 inches
Pitch ratio	0.889	
Mean width ratio	0.20	
Number of blades	3	
Rates of projected to disk area	0.266	
Blade thickness fraction	0.04	

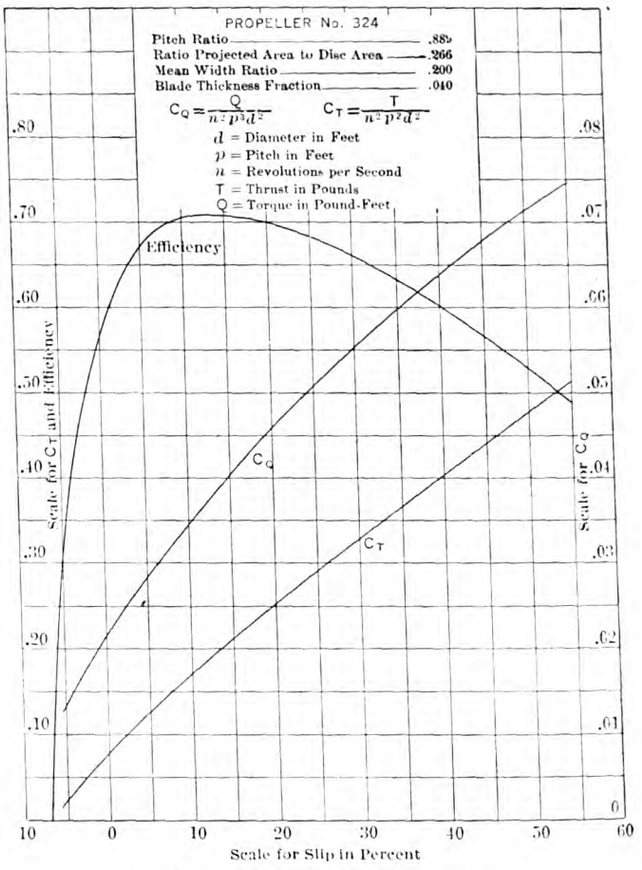

Fig. 5.—Curves of Propeller Characteristics

The propeller had three blades of Taylor's standard form.

The propeller characteristics were obtained by separate tests of the propeller model run in free water; that is, in a separate apparatus where the propeller shaft projected well ahead, so that the propeller ran in water undisturbed by the action of the testing apparatus. The same motor dynamometer was used for the tests as was used for the self-propulsion tests, the only difference being that the propeller shaft was coupled to the forward end of the armature shaft instead of the after end.

The characteristics of the propeller are given in Fig. 5. The thrust constant, C_T, and the torque constant, C_Q, are plotted on nominal slip following the method used by Schaffran.* These constants, which are in non-dimen-

* "Systematische Propellerversuche"; K. Schaffran, Schiffbau, September 22, 1915.

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sional form, lend themselves well to the analysis of self-propulsion experiments and to the extension of the results to the full size ship.

The results of the investigation are given in Figs. 6, 7 and 8. An examination of the effective horsepower curves and the shaft horsepower curves for the different models shows, as would be expected, a wide variation in power required. By plotting cross curves of power at a speed of eleven knots it will be found that for both the effective horsepower and the shaft horsepower the best results are obtained when the middle section of the parallel middle body is placed about 43 percent of the ship's length from the forward perpendicular. But 2,000 shaft horsepower is required for the ship represented by model 2,133 at a speed of 11 knots. This is considerably below

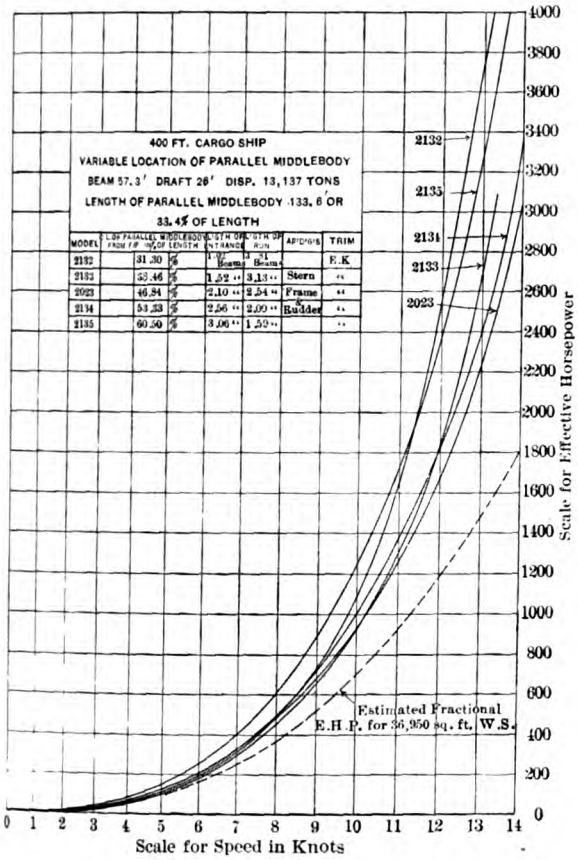

Fig. 6.—Curves of Effective Horsepower

that obtained with the ordinary 400-foot cargo ship of this displacement and may possibly be questioned as to whether it is not lower than could be expected to be obtained on a real ship. It must be remembered, however, that the lines are of good form and the friction of the shaft has been eliminated, so that the powers given do not include shaft friction. As to the reliability of the method followed, it may be stated that in similar experiments made on a model of the twin-screw collier *Jupiter*, for which are available accurate trial data, the results of the model tests, when extended to the ship, agreed identically as regards the propeller revolutions and within one percent as regards power and propulsive coefficient.

In Fig. 8 are shown the curves of wake fraction, thrust deduction coefficient, apparent slip, and true slip for the ship. In extending the results of the model experiments to the full size ships, it has been assumed that the wake fraction and thrust deduction coefficient for the ships are the same as for the models. The apparent slip and the true slip for the ship are less than for the model, because of less relative resistance, owing to the fact that the

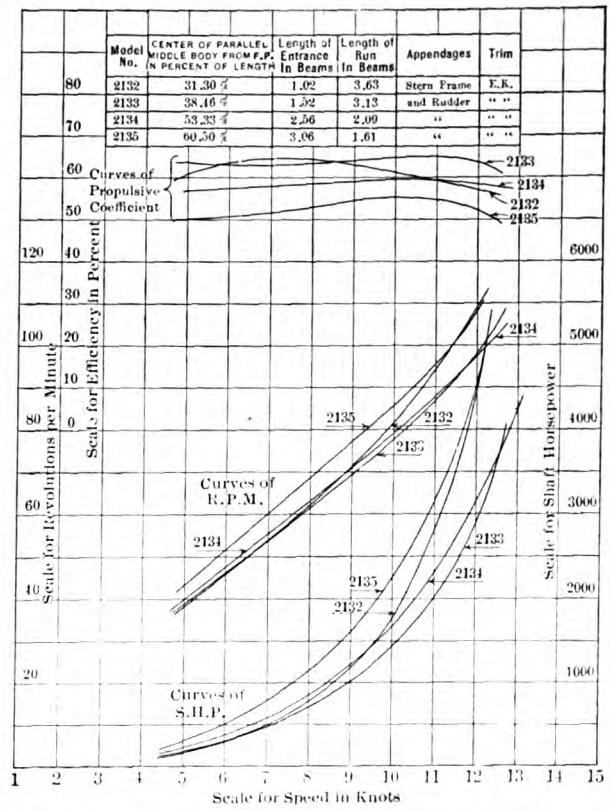

Fig 7.—Curves of Shaft Horsepower, Revolutions per Minute and Propulsive Power

frictional resistance increases less rapidly than if it followed the law of comparison.

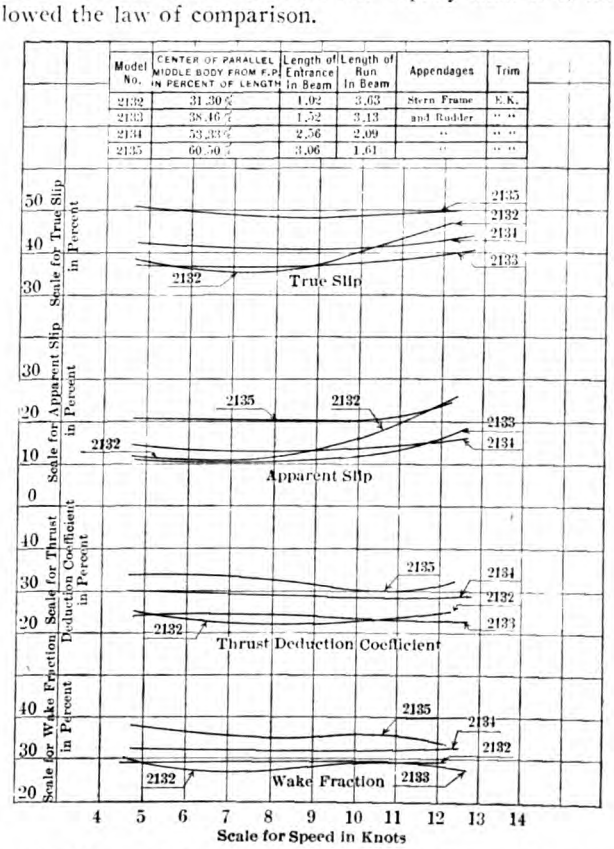

Fig. 8.—Curves of Wake Fraction, Thrust Deduction Coefficient, True Slip and Apparent Slip

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In order to avoid confusion in terms, the following definitions of thrust deduction coefficient, t, and wake fraction, w, are given:

$$t = \frac{T - R}{T}; \; w = \frac{V - V'}{V},$$

in which T is the thrust of the propeller, R the resistance of the ship, V the speed of the ship, V' the speed of advance of the propeller in the water in which it works.

As was to be expected, the wake fraction and thrust deduction coefficient both increase with fullness of the stern. It is interesting to note that in all cases the wake fraction is considerably greater than the thrust deduction coefficient, resulting in a hull efficiency greater than unity. The wake fraction obtained for the different models at a speed corresponding to 11 knots for the ship varies from 0.29 to 0.35.

The formula for wake fraction given by Taylor is as follows: $-w = -0.05 + 0.5b$, in which b is the block coefficient. This would give for all of these models a wake fraction of 0.336. The average of the results obtained in these experiments is 0.31, which is but slightly less than that estimated by the above formula.

Discussion

BY REAR ADMIRAL C. W. DYSON, U. S. N.

I have been cognizant for quite a long time of the work being carried on by Commander McEntee along the lines as outlined by him in this paper, but have never heretofore had the opportunity to scrutinize the results obtained by him except in one instance, that of the propeller designed by myself for the *Eagle* boats.

In this latter case the results obtained in the model tank agreed so closely with the estimates of performance as computed by the Bureau of Steam Engineering, and from indications obtained on the trial of the first of these vessels so closely with the actual performances, as to instill into my mind a great confidence in the accuracy and a supreme appreciation of the value of model propeller experiments as now conducted by Commander McEntee.

Close Agreement of Model Experiments with Estimate of Performance

Commander McEntee has requested me to analyze the propeller which he used in his experiments and to make an estimate of its performance behind the various hulls which he has used in order to ascertain the degree of agreement between the results obtained by the two methods. In order to give a clear understanding it will be necessary to give a brief description of the method used by me and which has been obtained by many years' study of the performances of actual propellers driving actual ships over carefully measured courses.

The form of propeller blade selected from which to derive the design or performance factors is that of which the projected area is an oval with the greatest circular width at .7 the radius of the propeller from the center. From these performances a series of basic curves of design have been obtained from which the performance of the propeller under these basic conditions can be obtained and the performance of the propeller under any other conditions of performance derived from this basic performance by the application of suitable factors entailed by the changed conditions.

The basic conditions are denoted as follows:

$I.H.P.$ = basic indicated horsepower.
$S.H.P.$ = $I.H.P. \times .92$ = basic shaft horsepower.
$P.C.$ = basic propulsive coefficient with maximum hull efficiency. (Taken for total projected area ratio.)
$E.H.P.$ = $I.H.P. \times P.C.$ = basic effective (tow-rope) horsepower.
$P.A. \div D.A.$ = projected area ratio (outside .2 diameter) of 3-bladed basic propeller.
$4/3\ P.A. \div D.A.$ = projected area ratio of 4-bladed screw.
$2/3\ P.A. \div D.A.$ = projected area ratio of 2-bladed screw.
$1\text{-}S$ = 1 — basic apparent slip (for 3 blades) and for fullness of after body of vessel.
$I.T._D$ = basic indicated thrust in pounds per square inch of disk area of the propeller.
D = diameter of propeller in feet.
P = pitch of propeller in feet.
$T.S.$ = basic tip speed (3 blades) in feet, of propeller.
v = actual speed of vessel.
$e.h.p.$ = effective (tow-rope) horsepower for v.

The power required to deliver $e.h.p.$ where no cavitation exists is expressed by $I.H.P._d = I.H.P. \times K \div 10^Z$ where Z depends for its value upon the value $\frac{e.h.p.}{E.H.P.}$ and K is the thrust deduction factor.

The revolutions corresponding to the actual conditions of resistance are found by the following equations:

$$s = \text{apparent slip} = S\,\frac{I.H.P._d \times A_V}{I.H.P. \times A_v} \text{ and } R_d = \frac{v \times 101.33}{P \times (1 - s)},$$

where S is the basic apparent slip and A_V and A_v are factors depending upon the values of V and v.

It should be borne in mind that slight variations in the form of blade have only slight effect upon the efficiency so long as the same projected area is retained, but do have a considerable effect upon revolutions, therefore, we should be prepared to find but small differences between the estimated and tank powers if both methods are correct, but considerable variation in the revolutions as the propeller used by Commander McEntee had blades of the Taylor form, while the standard blade form used by me, as already pointed out, is an oval.

ESTIMATE OF PERFORMANCE—SHAFT HORSEPOWER

Hull.	v	e. h. p.	e. h. p. / E. H.P.	Z	K	Est. Power.	Tank Power.	Log A_V	Log A_v	s	Est. Revs.	Tank Rev s.
2132	8	480	.1415	.89	1.27	735	750	3.48	2.78	.09	60.4	62
	10	1100	.3243	.51	1.27	1762	1800	3.48	3.01	.1274	78.7	80.5
	12	2580	.7607	.12	1.27	4325	4500	3.48	3.23	.1885	101.6	109
2135	8	610	.1799	.74	1.41	1153	1225	3.51	2.78	.1379	63.75	69
	10	1240	.3656	.455	1.41	2220	2250	3.51	3.01	.1564	81.44	86
	12	2500	.7371	.138	1.41	4607	4550	3.51	3.23	.1955	102.5	109
2133	8	450	.1327	.91	1.27	702	725	3.48	2.78	.086	60.8	61.5
	10	925	.2727	.588	1.27	1472	1480	3.48	3.01	.1065	76.9	77.5
	11					2030	2000				86.0	87
	12	1825	.5381	.276	1.27	3020	2850	3.48	3.23	.1316	94.9	98.5
2134	8	490	.1445	.855	1.27	796	850	3.48	2.78	.098	60.9	63
	10	1000	.2949	.553	1.27	1596	1700	3.48	3.01	.1154	77.66	79.5
	12	1825	.5381	.276	1.27	3020	3150	3.48	3.23	.1316	94.9	97.5
2023	8	480	.1415	.89	1.27	735		3.48	2.78	.09	60.4	
	10	925	.2727	.588	1.27	1472	No data	3.48	3.01	.1065	76.9	No data
	12	1660	.4895	.326	1.27	2679		3.48	3.23	.1167	93.3	

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In determining the block coefficient to use for basic apparent slip, the open water (where the propeller is not covered by the limit of the load water plane of the ship) correction is applied for hulls 2132, 2133 and 2134, directly to the standard block as ordinarily obtained for hulls of the given length, beam and displacement, while for hull 2135, which had abnormally full after body lines, this same correction has been applied to an increased standard block, this block being .80 in the first three cases and .85 in the latter, the corresponding open water blocks being .532 and .61.

The work of analysis and estimate appears in the accompanying table, the estimated and tank powers and the estimated and tank revolutions being placed in parallel columns.

The hull characteristics are as follows:

$L.B.P. = 400$ feet
$B = 57.3$ feet
$H = 26$ feet
Displacement $= 13{,}137$
Nom. B.C. $= .7716$
$B. \div L.B.P. = .1433$
Stand. B.C. for $K = .80$
Est. Stand. B.C. for K (hull 2135) $= .85$
$D < \cdot 7\ H \therefore$
Stand. S.B.C. for $V = .532$
Stand. S.B.C. for V (hull 2135) $= .61$
$K = 1.27$, for 2135 $= 1.41$

The basic condition of propeller shows:

$P.A. \div D.A.$ (3 blades)	.266
D	16.583 feet
P	14.75 feet
$T.S$	.5900
$P \times R$	.1671
$1 - S$ (for S.B.C. .532)	.89
(for S.B.C. .61)	.90
V (for S.B.C. .532)	14.67
(for S.B.C. .61)	14.84
$I.T._D$	3.1
$I.H.P.$	4880
$P.C.$	.695
$E.H.P.$	3392
$S.H.P.$	4490

The agreement between the two power columns is so close, that it appears to me that Commander McEntee has developed a method for obtaining quickly and cheaply all such data as it has taken me years to collect and from the data so obtained not only to deduce absolutely correct factors for propeller design but also to classify hulls along such definite lines that the performances of combined hull and propeller can be forecasted with the minimum of error. He is most heartily to be congratulated upon the results of his labors up to the present time, and I hope and trust that he has not yet reached the end of his investigations.

Building the Ford Submarine-Chaser "Eagle"*

Simplicity of Hull Construction—Safety Devices on Unusual Launching Platform—Routing Aids Production

TANK testing is begun at station 6 and completed at the final station. The work at station 6 includes setting of deck houses and chart house, completion of some interior riveting, setting all the stern-shaft bearings and lining up preparatory to bolting, and the installation of pumps, distillers, evaporators, and fuel oil pipes and bilge pipes. At station 7 the rear two trucks of the ship's carriage are removed and the boring bar for the shaft bearings is placed, and the bearings are lined and bored. Valves are set, oil tanks cleaned, electrical work is begun, and finally the propeller shaft, propeller and rudder are set in place. The hull having in the meantime been cemented inside, the ship is ready to pass out of the assembly shop and go to the launching platform.

As soon as launched, and while on the way to the fitting-out dock, the ship is inspected in detail, and various minor operations are carried on to get the hull ready for the installation of machinery.

Hulls Checked Up by Transit and Level

After experience in hull erection showed that complete assembly of the main framing at station 1 was not possible, it was discovered also that slight changes of position of the hull were likely to occur at all of the stations. A daily check-survey system was therefore established, in order to make sure of maintaining position and alinement. A survey corps checks up level and line of keel and verticality of frames and centerline daily, making the rounds of the twenty-one hulls. Any misadjustment is at once corrected by the wedge keel blocks and by shores.

Removal of the last two trucks of the carriage at station 7 results in a slight deflection of the stern portion of the ship, which is important with respect to the subsequent setting of the turbine reduction gear. Care must be taken to see that the stern does not drop below its position when afloat and ready for the gear installation. The shaft bearings being bored at station 7, the adjustment of the ship to its buoyancy distribution after launching tends to raise the forward end of the shaft and bring the turbine gear foundation slightly low. In this position of parts the gear is easily adjusted by shimming to correct alinement with the shaft, and all risk is avoided of having the shaft so low as to require cutting down the gear foundation in order to line up the machinery.

Drive 20,000 Rivets Daily at Each Station

About 243,000 rivets, most of them ½-inch and ⅝-inch, are contained in the "Eagle," and of these more than 200,000 must be driven on the hull erection carriages. For the ultimate rate of production of the plant—one ship a day—it will be necessary to drive more than 20,000 rivets daily at each of nine stations (stations 3 to 5 on three working lines). In view of the magnitude of this daily task, the rivet handling methods are especially interesting.

By far the greater proportion of the rivets are countersunk, with a 60-degree angle of countersink and with point shaped to ⅛-inch rise. This "mushroom" point gives greater strength than a flush point, and also makes the driving easier by the use of a slightly cupped rivet set in place of a flat one.

All rivets as received are cleaned of dirt and loose scale in two tumbling barrels set up in a rivet handling inclosure near the center of each supply bay. From here they are distributed, in bright and clean condition, to their various stations. If used in the heaters in the condition as originally received, scaling would cause constant trouble in the heater.

*Abstract through courtesy of *Engineering News-Record*.

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Electric rivet heaters are among the remarkable innovations in the "Eagle" manufacture. They were designed by E. F. Allison, chief electrician of the Ford Motor Company. Such a heater comprises a simple transformer whose secondary circuit terminates in a jaw having upper and lower contact plates, the upper one spring-mounted, between which the rivet is placed in vertical position. The contact resistance of the large current flowing through the rivet produces the proper riveting heat in about 30 seconds—just time for taking the hot rivet to the ship and returning to the heater for the next. Heating is most rapid at the point, the head brightening up last.

A convenient riveting scaffold is another innovation. It consists of hook-ended hangers with laterally projecting bolts, and similarly hook-ended bracket members, which can be placed instantaneously. The hangers are hooked over the top of the shell; extension lengths can be hooked to their lower ends just as easily.

Fig. 5.—At Work on Keel and Bottom Plating

A sharp departure is made from the ordinary shipyard practice of countersinking the plates in the punch shop before they come to the ship. At the "Eagle" plant the countersinking is done on the ship, when the plates are in place. It is combined with the operation of reaming, through the use of a reamer shaped with a countersink taper in its rear portion; a stop on the tool assures correct depth of countersink. One advantage of this procedure is that perfectly true countersinks are obtained, whereas when the countersinking is done in the punch shop the subsequent reaming of holes not perfectly matching shifts the axis of the hole and results in forcing the head to one side of the shaft of the rivet. This gain in rivet quality, and the elimination of such errors as countersinking the wrong side of the plate, which may occur in the case of shop countersinking, are decisive advantages, although the hand countersinking proved to be rather heavy work in the 12-pound shell plating.

With all frames straight, with no plates except those of the bilge strake requiring to be curved in bending rolls, with only four furnace plates under the keel (one of these is die-forged in an outside plant and is received at the "Eagle" factory ready shaped), the manufacture is largely reduced to simple punching and assembly work arranged in the manner described. Furnace bending is practically limited to the shaping of the watertight boundary angles of the bulkheads. Only one set of bending rolls is provided in the punch shop, which is sufficient to take care of the bilge plate. Flanging the frame members and brackets is done cold by two large plate benders.

Simplicity of the Hull Construction Work Largely Due to Design

These elements of simplicity are to be credited to the Navy Department's original design, which, as already stated, was conceived with factory production in view. Notable elements of the design, besides those mentioned and those represented in the frame section, are the use of V-shaped keel plates, the avoidance of forgings and complex plating at stem and stern, straight-line longitudinal shaping so that both bottom and shell plates can be drawn into position directly from the flat, and elimination of joggling by using short, tapered liners, not only at butt laps but also on the frames, under the out-plates of the shell, these plates being drawn in to the frames. The boundary angles of watertight and oiltight bulkheads are stapled to fit the plating.

Unusually numerous lightening holes in floors, frames, brackets, etc., are called for by the design. They are produced very expeditiously, however, and do not make the shop work less simple. The smaller holes are stamped out while the larger one are burned out with oxy-acetylene flame. Flame welding is also used extensively, chiefly for the corners of bulkhead angles and similar work.

Plates ranging in weight from 6 to 12 pounds per square foot make up the structure of the ship. Stanchions are made of tubes pressed flat at the ends for riveting to angle clips at the floor and deck connections. Making the keel plate part of the shell plating eliminates the necessity for edge-planing, as required in ships of ordinary design at the junction of keel and shell plate. A warped surface occurs in the rear portion of the ship's bottom; the shell plating here can be drawn down to the frames without difficulty, however.

Laying Out Plating by Graphical Projection

When the designers in the Ford Motor Company's shipdrafting force carried out the detailing and undertook to work out the plating for a maximum amount of multiple punching, they found a considerable gain in accuracy by laying out the plating on the drafting board by graphical projection to a scale of 3 inches to the foot. The results of this process checked against the mold loft layout proved to give superior accuracy and furnished a satisfactory basis for fixing the dimensions of plate and laying out the riveting.

In the search for further simplification of manufacture, electric welding of bulkheads, deck houses and other parts not calling for great structural strength is being introduced. The stimulus for the attempt came partly from the successful ship work done in England in electric butt welding. Recently a complete athwartship bulkhead was made up by welding, and steps were taken to systematize the work for regular application.

"Quasi-arc" welding is used. The joints of the plating are butt welded, while the boundary and stiffener angles are attached by edge welding and intermediate welding, as sketched. The first intermediate welding tried was like that used in the English experiments, the angle leg in con-

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tact with the plate being notched, so as to bring part of the welded toe edge close to the position of the ordinary rivet line. As an improvement on this, elongated holes were punched in the angles, and the edge of the angle along the inside of this hole was welded to the plate.

From the last station of the assembly shop, the completed hull passes out through one of three large steel rolling doors in the end of the building—the largest steel curtains ever used— and, still mounted on its carriage, moves forward for transfer to the launching platform.

This operation is accomplished by a transfer table which, except for its length, 200 feet, is precisely like those used in locomotive shops. It runs on 11 rails transverse to the axis of the plant, and is carried by two wheels per rail, one of the two being driven from a longitudinal shaft connected to an electric motor at mid-length. The deck carries four rails, two for the hull carriages and two for the outriggers or steadying plates of the carriage. Forward of the transfer table, at its right end, is the launching platform, to which the ship is moved over a short length of approach track.

W. B. Mayo, chief engineer of the Ford Motor Company, is credited with originating the idea of lowering the finished hulls into the water by a vertically moving hydraulic elevator. Carried out with remarkable excellence of detail, the scheme has proved completely successful.

This platform is a steel truss bridge 200 feet long, supported at the quarter points of its length by two transverse trusses whose ends, 14 feet out from the bridge trusses, are attached to two vertical 4-inch hanger rods, which are the piston rods of vertical hydraulic cylinders. Concrete pedestals 8 feet high above water support these cylinders; the deep slot between the two pedestals of each pair, extending to the bottom of the slip under the bridge, gives space for the ends of the cross-frames of the bridge as the lowering proceeds.

In the operating house, on the bank alongside the launching platform, is a duplex high-pressure pump furnishing water at pressures up to 500 pounds. A control stand with four pairs of valves provides for independent operation of the eight cylinders, but an ingenious dial indicator directly in front of the control stand shows by four separate hands the position of each pair of pistons and of the center point of the platform. The operator is able to keep the platform level within ¼ inch. About thirty minutes' time is required for the complete launch.

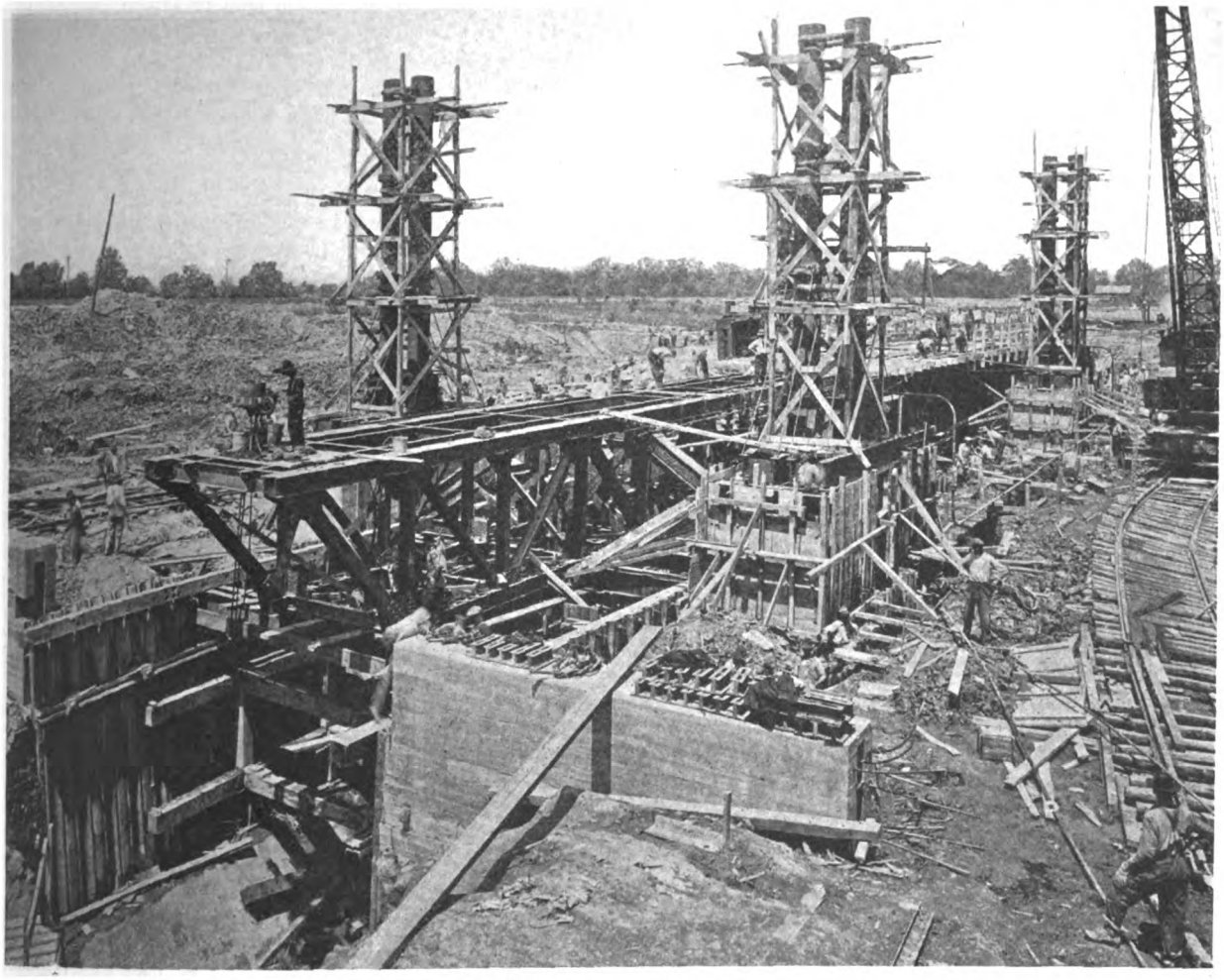

Fig. 6.—Launching Platform and Hydraulic Jacks During Early Stages of Construction

Safety Devices Control Launching Platform

Two mechanical safety devices are embodied in the launching platform construction. To take the weight of the empty structure when in its normal (upper) position, a supporting girder is placed under each end, bridging the width of the gap between lateral forward extensions of the abutment pier. This girder can be pulled back out of the way—after the platform is raised an inch or two—by pulling-screws engaging the ends of the girder and a pair of upward-projecting lugs fastened to the back of the abutment. Further, locking bolts pass through links in

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the eight piston-rod hangers. The pistons cannot be lowered until these bolts are withdrawn. Two hand levers at each pair of cylinders are provided to actuate the bolts.

Saving labor and time in the fitting-out operation is accomplished by virtue of the progressive system of layout and working, with little aid from mechanical appliances. The work of installing the machinery and fittings of the ship and placing its many pieces of equipment is broken up into a succession of segregated items, carried out in seven consecutive positions of the ship alongside the 2,000-foot fitting-out dock.

Systematization in the Fitting-Out Plant

To characterize the arrangement of these operations, the following partial schedule of items performed at its seven stations (stations 9 to 15) is quoted:

Installing boilers, uptake and mounting is the principal piece of work at station 9. The deck over the boilers is riveted, boiler piping and a considerable amount of other interior installation are placed, and anchors and windlass are added to the ship. At station 10 the steam turbine and its reduction gear are set, shafting and the bulk of all the piping are installed, the chief electrical work in the ship is done, and the stack is set. Most of the furring is placed at station 11, and the air test of various compartments is made. At station 12 many items of rigging are put in place, from ventilating cowls to masts, spars and davits; fire extinguishers, whistle, plumbing fixtures and radiators are set, and the ice machine is put into the ship. Some electrical work is also done at this station. Other items of equipment and part of the naval installation are set in place at stations 13 and 14. Making the ship ready for sea begins at station 14 with loading the fuel oil tanks. At station 15 the final items in this part of the work are performed, including raising steam and testing the piping.

Special Handling Machinery

Long sheds built on the fitting-out dock, some 20 feet inshore of its face, supply the materials and equipment in corresponding order. A locomotive crane running on a track on the dock in front of the sheds handles the material into the ship.

Ford factory methods find application in a special rig used at the first of the seven stations, where turbines and boilers are installed in the ship. It serves for assembling the boilers, which arrive as drum-and-tube units without casing. The steel plate and firebrick casing must be built up around the steam element before the boiler is transferred to the ship. For this work an assembly skidway is provided in the shed. It consists of a pair of I-beam rails mounted on low concrete pedestals, and extends about 100 feet longitudinally down the shed. The boiler casings are built on small flat-wheeled carriages running on the skidway, as sketched.

Boilers Routed Through Shop

Starting at the middle of the length of the skidway, the boilers are built up progressively and are shifted step by step toward the ends, going to different workmen for successive operations in the assembly. They reach the ends of the skidway in finished form, and here are run out through a door in the front of the shed by means of a transfer table composed of a length of skidway mounted on wheels. With ideal working of the system the two boilers required for a ship are started simultaneously at the middle of the skidway, and several days later are completed and pass out of the shed at the same time, so that they can be set in the ship during its one-day stay at that station.

Supply of hull material to the "Eagle" plant is provided for by a punch shop that is easily among the largest in the world. As early as two months ago this plant was turning out material at the rate of 160 tons per day. On the basis of completing one "Eagle" daily, the ultimate production of this shop will be about 200 tons, a production that is being approached rapidly. Because the "Eagle" plating is only one-third to one-fourth as thick as that of steel merchant ships, the capacity of the shop in terms of ordinary ship material is 600 to 700 tons per day, or 15,000 to 20,000 tons a month.

Multiple punching is the basis of the shop equipment. When the work in the designing room had demonstrated that a large part of the shell and deck plating of the ship could be multiple-punched, ten machines for the work were fitted up from sheet-metal punch presses of the Ford Motor Company's automobile works. Thomas spacing tables were added at the feeding-out side, and the necessary gangs of punches with gag levers were built into the frames.

Shop Is Well Planned

The shop is a timber-frame building about 100 by 450 feet, its long dimension set across the direction of travel of the material. At its rear, facing the storage yard, a lean-to 60 feet wide extending all the way across the building provides space for marking out and for a considerable amount of single punching. There is a smaller lean-to on the opposite or forward side of the building.

In the storage yard back of the punch shop the plates are piled flat (not set in racks), and many of them are handled into the shop by hand. Locomotive-crane tracks traverse the yards at right angles to the longitudinal alinement of the plant, to place material in storage from cars or to assist in handling it into the shop.

In the rear lean-to of the punch shop are installed eight single punches, two plate shears and one circle-cutting shear. Most of the space of this lean-to, however, is devoted to marking the single-punched plates, which is done by center punching through metal templets. These templets are stored in racks alongside the punch table. Material passes forward from here on small hand trucks and roller beds to the punches in the main building.

Multiple Punches Dominate Shop

In the shop itself, the multiple punches dominate the arrangement. There are seven plate multiples, most of them of 72-inch gap. The plates to be punched average about 50 inches in width and usually require a gang of about 24 punches; they are fed through by hand. In addition there are three narrow multiples, eight single punches, one angle shear and punch, one blocking-out press, a horizontal punch for curved angles, two plate benders (flangers), one set of bending rolls, a pair of small furnaces with bending slabs adjacent, and a row of blacksmith forges. In the shed on the outgoing side of the punch shop are two plate-edge shears.

No storage space for finished material is provided at this shop. The outgoing material is handled directly on small railway trucks into the assembly shop, where it is taken down the supply bays to storage adjacent to the station where required for erection.

An important improvement is being made in the punching of narrow plates and frames by the use of a special automatic spacer, capable of dealing with plates not ordinarily adapted to multiple-punch work. This ingenious device, originated by Joseph Dorschel, superintendent of the shop, punches plates in which the transverse lines of holes are not exactly at right angles to the longitudinal axis of the plate.

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A New Automatic Spacer in Use

Between the rails of the feeding-out bed of the press is laid a metal pattern, over which rides a small carriage attached to the leading end of the plate to be punched. A handle on this carriage serves for pulling the work plate forward through the punch. A transverse row of small vertical plungers or detector fingers is spring-mounted in this carriage, and adapted to enter holes in the pattern. As the work plate is pulled forward, one of these fingers dropping into the hole in the pattern stops the work. At the same time the punch operator sees the end of this finger depressed, and he pulls the corresponding gag lever of the punch, thereby producing a hole in the work plate corresponding in location to that of the pattern. As he does this, the feeder lifts the pulling lever, thereby disengaging the depressed finger, and pulls the work forward until another finger finds a hole in the pattern. By this arrangement, punching of holes irregularly arranged along several longitudinal lines is easily done, with accurate spacing; marking out is eliminated.

Working Force at the "Eagle" Plant

Estimates of operating organization call for a total force of about 11,000 men to operate the "Eagle" plant. The probable ultimate force will include about 9,000 men in hull construction, and something more than 1,000 in the steam engineering work. A labor force of about 100 per station of the assembly shop will be required in each shift.

Work is carried on continuously through the twenty-four hours in three shifts—day shift, 7 to 3; evening shift, 3 to 11, and night shift, 11 to 7. The day shift force is one-third larger than those of the other two shifts.

Riveters Are the Main Problem

Riveters have been the main problem of the "Eagle" plant, as they have of regular shipyards. In the words of William Knudsen, superintendent of the plant: "We know we can punch 200 tons per day, and we know we can erect 200 tons per day; the pinch is in riveting. We are now driving 86,000 rivets per day at the maximum [this was in September.—Editor], and we want to reach 240,000 rivets per day. We are putting on green men at the rate of ten gangs per day, training them in the assembly riveting for final transfer to riveting on the hulls. An ultimate force of about 500 gangs of riveters is needed."

Considerable help was given to the organization of the plant by the transfer of about 40 skilled shipbuilders from United States navy yards, to act as instructors and help develop the working organization.

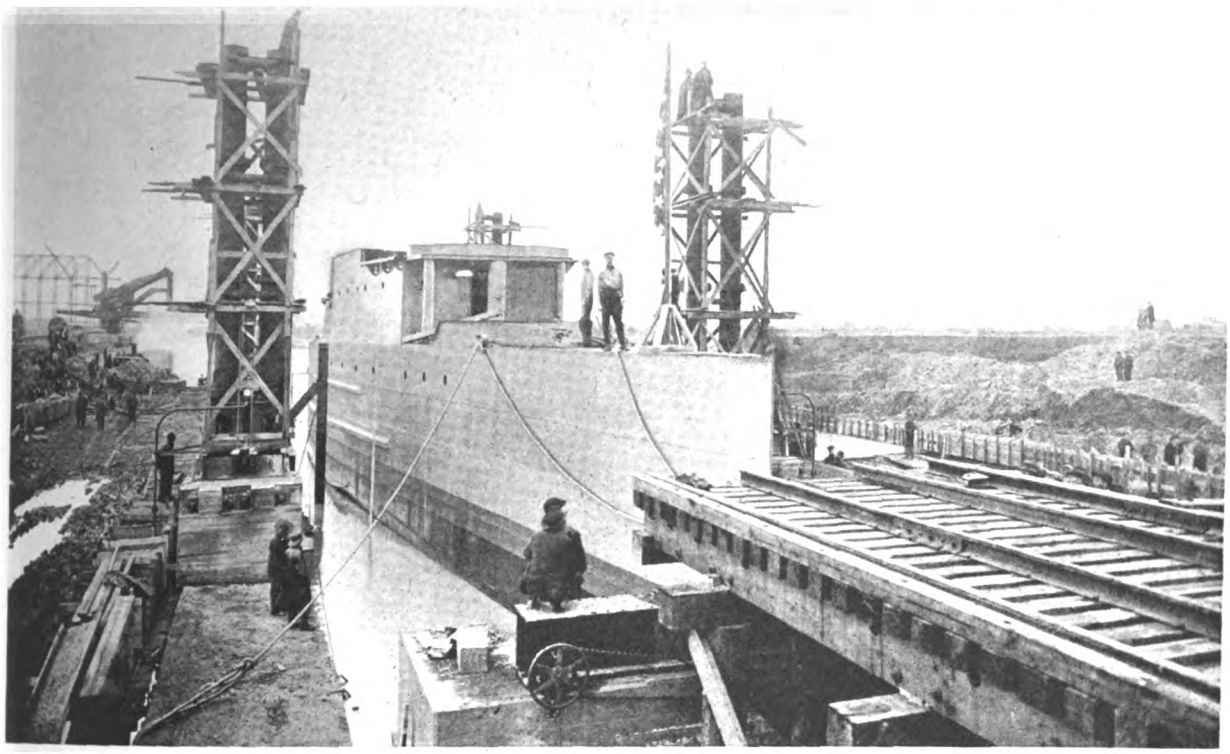

Fig. 7.—Ford "Eagle" Being Lowered, or "Launched," on Hydraulic Platform

Production Results Are Phenomenal

An outstanding feature of the organizing work is that hull construction did not begin until May 1, and that within four months from this time an organization of 6,000 had been created and was successfully producing "Eagles." Almost none of the entire force had prior shipyard experience. The building up of this great working force proceeded in spite of the fact that no housing facilities are available locally, and when construction began the nearest street-car line was about a mile from the yard. Since that time special provision has been made for transporting men to their work, and recently a street-car line has been extended directly to the plant.

The raising of censorship now permits news of the superdreadnought well toward completion at the Newport News Shipbuilding and Drydock Company. The keel of the 33,100-ton battleship was laid after this country went to war, and the vessel will be ready to launch within a few months. The main armament will consist of twelve sixteen-inch guns mounted in four turrets on the center line, two forward and two aft. Naval officials believe she will be equal to any warship on the seas.

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CAR RECORD

(1) CAR No.	(2) INITIAL	(3) ORIGIN	(4) DESTINATION	(5) MILL	(6) ORDER No.	(7) DATE ENTERED	(7) DATE SHIPPED	(7) DATE REC'D	(8) GROSS	(9) PLATE	(9) SHAPE	(9) BARS	(10) 87	(10) 88	(10) 89	(10) 90	(10) 91	(10) 92	(10) 93	(10) 94	(10) 95			ROUTING
6598	P+LE	MUNHALL Pa.	YARD	Homestead	3147	3/14	3/9	3/23	107040	✓			309	23.5										U.RR-PRR-LI.
276803	PRR	"	Fabricator	"	3147	3/16	3/12	4/11	113830	✓	✓			21.0	35.0									URR-PRR-NYNH+H
150888	B+O	POTTSVILLE Pa	"	Eastern S. Co	3149	3/18	3/5	3/16	77719				200	18.8										P+R Co of NJ-N.H.
325468	NYC	MUNHALL Pa.	"	Homestead	3147	3/18	3/10	3/24	111050	✓			17.0	20.0	18.5									URR-PRR-N.H
580475	PL	"	"	"	3147	3/18	3/10	3/24	105650	✓			32.1	10.0	10.7									Do
6045	LV	"	"	"	3147	3/18	3/10	3/25	110100	✓			15.0	20.0	20.0									Do
17829	GT	"	"	"	3147	3/18	3/10	4/5	103080	✓			18.3	12.2	21.1									Do
47898	P+R	Pottsville Pa.	"	Eastern Steel	3149	3/18	3/11	3/23	87450		✓		12.3	18.1	13.4									P+P-C of NJ-NH
387450	PRR	Phoenixville	"	Phoenix	3148	3/18	3/19	3/20	98750		✓		18.0	15.2	16.6									PRR Co of NJ NH
380672	PRR																							P+P-C of NJ-LI
273800	PRR	"	YARD	"	3148	3/19	3/16	3/26	74830		✓		12.0	14.3	11.1									Do
47630	P+R	"	"	"	3148	3/19	3/16	3/29	82170		✓		11.0	13.8	16.2									

Form A.—Showing Car Record

CAR TRACING SHEET

DATE

SHEET No. 1

U.RR.-P.R.R.-N.Y.N.H.+H.

DATE	CAR No.	INITIAL	HOWARD DAY	HOWARD TIME	HOWARD TRAIN	PITCAIRN DAY	PITCAIRN TIME	PITCAIRN TRAIN	ALTOONA DAY	ALTOONA TIME	ALTOONA TRAIN	MARYSVILLE HARRISBURG DAY	MARYSVILLE HARRISBURG TIME	MARYSVILLE HARRISBURG TRAIN	WEST MORRISVILLE DAY	WEST MORRISVILLE TIME	WEST MORRISVILLE TRAIN	GREENVILLE DAY	GREENVILLE TIME	GREENVILLE TRAIN	WESTCHESTER DAY	WESTCHESTER TIME	WESTCHESTER TRAIN	BRIDGEPORT DAY	BRIDGEPORT TIME SET		ORIGIN
3/12	276803	P.R.R.	3/12	✓	2252	3/13	5 50 A	PG				3/14 M	8 25 P	PG2 1463	4/5	4 55 A	1131	4/8	2 00 A	FL 51	4/10	5 40 A	X78	4/11	2 00 P		MUNHALL PA

Form B.—Showing Car Tracing Sheet

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Control of the Construction of a 5,000-Ton Deadweight Fabricated Steel Ship—V

Forms for Following Up Movement and Arrival of Steel Parts—Railway Shipments of Plates and Sheets Traced

BY FABRICATOR

PREVIOUS articles have disposed of the method of controlling the routine followed preliminary to securing the materials in the proper sequence and in time to meet requirements. The method of purchasing or securing the materials is a simple and direct routine, with success solely dependent upon the personalities of the individuals responsible, so the method will not be covered in this series. The problem of storing and issuing the material after its arrival is comparatively simple and depends on the yard equipment—mechanical (and mental)—but recording and following up the movement and arrival of the various items, particularly steel, is a problem which requires special consideration. Only the steel records will be covered, but the methods outlined can be applied to any of the other items.

It is necessary to know when the mill will roll and ship each item and how long it will require the transportation company to make delivery, so as to know when each item will be available at the yard. The mills will submit an approximate rolling date for individual items when they cannot meet the customer's required delivery date for the total order, which, with our previous delivery schedules, covers the first condition.

On all shipments a reasonable time is allowed for delivery by the railroad company before tracing is started, unless the shipment is very urgent: then it may be traced by telegram through the car record of the railroad office or by a car tracer, who follows the cars personally. This last is quite expensive. A detailed record of the contents of each shipment completes the conditions.

When a shipment of steel is loaded a "shipping manifest" is sent by the mill to the yards, which bears the date of loading, the car initial, number and capacity, the point of origin or location of the mill, the destination and initials of the railroads over which the shipment is routed and a full detailed description of the contents of the load. This description covers the customer's order number or numbers against which the shipment applies; the mill order number; the number of pieces, dimensions, weight and marks of each item; the hull number, total number of items and total weight. This manifest is numbered consecutively by the mill and this number and the date of the manifest should always be used when writing the mill concerning the shipment.

Immediately upon receipt of the manifest at the yard it should be entered upon a "Car Record" sheet (Form A). The first five items need no explanation. The sixth is the yard Purchase Order Number. The first item under seven is the date the entry is made, the next the date shipment was made from the mill, and the last one the date the shipment was received. The eighth is the gross weight of shipment in pounds. The ninth describes by a check mark the contents of the shipment. The tenth is a distribution of the shipment in tons over the various hulls. The eleventh is the routing of the shipment to destination. This record covers the movement of all steel to both the fabricator and yard and is used as a "follow-up" on shipments and as a basis for a "Weekly Report of Steel Situation."

Fifteen days were allowed for delivery to either the yard or fabricator before a tracer was started. This allowed a

TO Steel Co

PLEASE FURNISH FOR ACCOUNT OF THIS COMPANY ORDER NO. 3147 SHEET NO. 10

MATERIAL FOR HULL NO. 87 to 95 Inclusive (AMOUNT FOR 1 HULL) DATE Jan 18th 1918

ITEM	NUMBER PIECES	LENGTH INCHES	LENGTH INCHES	WIDTH INCHES	WIDTH INCHES	GAGE	TAPER	MARKS	ESTIMATED WEIGHTS SINGLE	ESTIMATED WEIGHTS TOTAL
	FLAT KEEL PLATES									
1	1		296	"		15/16		SK 4	4520	4520
2	1		355	"		"		SK 5	5400	5400
3	1		320	"		"		SK 6	4870	4870
4	1		325	"		"		SK 7	4930	4930

Form C.—Material Schedule Covering Plates

TO Steel Co

PLEASE FURNISH FOR ACCOUNT OF THIS COMPANY ORDER NO. 3149 SHEET NO. 508

MATERIAL FOR HULL NO. 87 to 95 Inclusive (AMOUNT FOR 1 HULL) DATE Jan 19th 1918

ITEM	NUMBER PIECES	MATERIAL	DIMENSIONS	WEIGHT PER FOOT	LENGTH FEET	LENGTH INCHES	MARKS	ESTIMATED WEIGHTS SINGLE	ESTIMATED WEIGHTS TOTAL
	VERTICAL KEEL ANGLES								
131	1		3½x3½x7/16	9.8	27	2	VKA9-22	266	266
132	1		4x4x½	12.8	22	7	9-19	288	288
133	1		4x4x9/16	14.3	42	11	19-38	612	612

Form D.—Material Schedule Sheet Covering Shapes

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STEEL REPLACEMENTS AND CORRECTIONS

HEAT No.	MILL INVOICE No.	MILL INVOICE DATE	CAR No.	CAR INITIAL	DIMENSIONS ORDERED	DIMENSIONS RECEIVED	MARK	LETTERS				REPLACED DATE	REPLACED CAR	REPLACED INITIAL
✓	HD19300	3/28	859303	P.L.	243½x49x9/16	MISSING	SLD-5	7/15	7/16	7/1	7/16	7/18	10972	B&S
✓	HD15428	3/13	282443	P.R.R.	275x40½x3/8	"	FL-41	5/16	5/18	6/15	7/15	7/12	315131	P.R.R.
14785	HD16070	3/15	324921	N.Y.C.	333x57½x5/16 2 Pcs	333x57¼x5/16	SA-11	7/1	7/3	7/8		9/29	29728	C&O 2 Pcs
✓	HD15428	3/13	282443	P.R.R.	67x39x3/8	MISSING	KB-51	5/16	5/18	6/15	7/15	7/12	315131	P.R.R.

Form E.—Steel Replacement Sheet with Data to Adjust Missing or Faulty Shipments

safety factor of fifteen days, as thirty days were allowed on the schedule for railroad deliveries.

A "Car Tracing Sheet" (Form B) was made up for each routing, showing all passing points. This was used when a shipment was behind its fifteen-day schedule, or in case a very urgent shipment required "wire tracing." Referring to Form A, Car 6598 was in one day ahead of schedule and so does not appear on the sheet, but Car 276803 was about fifteen days behind schedule. This was entered on Form B, and on tracing was found to have moved nicely till it reached West Morris, where it had been shopped. In this case a personal investigation was made and it was found that the draft rigging of the car had been seriously damaged. The railroad company offered to transfer the load, if repairs were not made by a certain date, which was not required.

Form C is a "Material Schedule Sheet" covering plates, and Form D is one covering shapes; supplementary sheets were also made on a duplicating machine and ruled so as to face the Forms C and D when bound in the binders. The car number and initial of each shipment was entered at the top of the sheet; the material mark was entered in the left-hand margin to facilitate checking and number of pieces of each item entered under the car in which they were shipped and opposite the material mark. The date the car arrived at its destination was entered in the top margin opposite the car. This gave at a glance the condition in detail of any item.

Discrepancies and shortages in shipments occur which need immediate action, and the burden is on the yard, as the mills meet all such reports with prompt action and investigate at their convenience. For this reason all items which do not check in dimension should be placed in a "hold over" pile; a record made of the heat number or other marks of identification, and this, together with the differences, reported immediately to the mill. To simplify this work (Form E) a "Steel Replacement" sheet was provided, which carried all of the information necessary to support a claim for variation in dimensions or a shortage caused by a missing item. This saved the labor of going over all of the records in order to work and close a claim.

TONS REQUIRED
PLATES 1336
SHAPES 575

WEEKLY REPORT OF STEEL SITUATION

HULL 87

DATE	TOTAL RCD. BY YARD FROM MILLS: PLATES	TOTAL RCD. BY YARD FROM MILLS: SHAPES & BARS	TONNAGE RCD BY FAB'R.	TONS FAB. BY YARD	FAB. TONS RCD. BY YARD	TONS ERECTED	STEEL ON HAND AT YARD: FABRICATED	STEEL ON HAND AT YARD: PLAIN MATERIAL: PLATES	STEEL ON HAND AT YARD: PLAIN MATERIAL: SHAPES	STEEL EN ROUTE: MILLS TO YARD	STEEL EN ROUTE: MILLS TO FAB'R	STEEL EN ROUTE: FAB'R. TO YARD	TONNAGE RCD. BY FABRICATOR: PLATES	TONNAGE RCD. BY FABRICATOR: SHAPES
3/30	309	23.0	132.7	none	none	none	none	30 9	23.0	none	18.0	none	824	50.3
4/6	50.9	33.0	177.8	none	15.0	80	7.0	50.9	33.0	28.0	39.8	20.0	112.5	65.3
4/13	67.0	50.0	248.4	3	35.0	31.0	7.0	67.0	47.0	19.0	50.0	none	167.8	80.6
4/20	103.0	50.0	516.3	8	139.0	128.0	19.0	95.0	43.0	39.3	80.0	98	380.1	136.2
4/27	183.0	80.0	709.0	31	237.0	253.0	2.0	162.0	70.0	40.0	93.1	152	493.0	216.0

Form F.—Weekly Report of Steel Situation Carried for Each Hull

To file the manifests so as to be readily accessible, heavy pasteboard folders were numbered one to nine and the manifests filed by the first figure of the car number; that is, car 5048 or 578601 or 50 would be in folder marked "5." It is not necessary to consider the car initial.

To know the progress of the yard and fabricator, a "Weekly Report of Steel Situation" (Form F) was carried for each hull. Information as to material in transit and received was obtained from the "Car Record" sheet, and material fabricated and directed was covered by daily reports from the yard and fabricator.

The methods covered in this series of articles may be developed to fit the requirements of any yard. They are in use now and have given very good service, and the use of graphs in conjunction with the schedules makes it a very complete though simple control.

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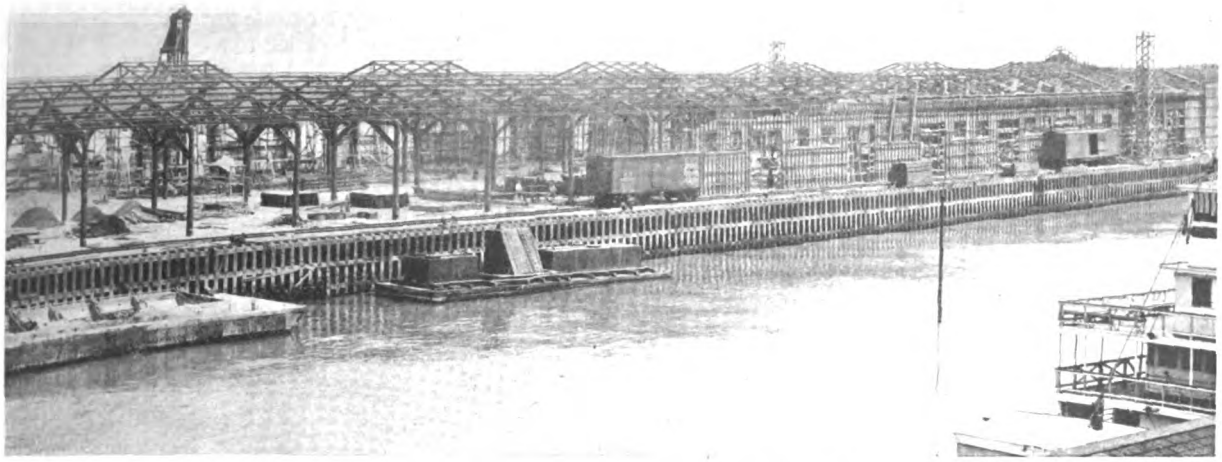

Fig. 1.—Steel Construction and Wood Bulkhead of a Pier Recently Erected

Harbor Improvements at San Francisco

Extensive Enlargement of Piers—Large Bulkhead Warehouses—Railroad Connection with Piers—Developments in Islais Creek Section

BY CHARLES W. GEIGER

THE Board of State Harbor Commissioners have completed plans for the immediate construction of $2,000,000 (£410,000) worth of harbor improvements at San Francisco. When completed, these improvements, in conjunction with the improvements now under way, will greatly increase the capacity of the present wharf space and will relieve the seasonal freight congestion, which has troubled the shippers here for years.

At the present time there are 49 active piers, with a cargo area of 5,712,080 feet, which is equal to 131 acres. There is a total berthing space of 15 miles, capable of accommodating at one time 245 average size vessels coming into the port.

Since 1911 there have been constructed 26 piers with a total area for cargo of 2,799,394 square feet, or about 65 acres, having a berthing cargo space of 34,137 lineal feet, sufficient to accommodate at one time 105 vessels of average size now entering the port. In addition, the port, since 1911, has reconstructed ten of the old piers with cargo area of 817,211 square feet, with a total berthing space of 13,444 lineal feet, sufficient to accommodate 41 vessels. In addition to the foregoing work, there has been constructed, since 1911, bulkhead wharves of a total length of 9,465 lineal feet from 45 to 80 feet in width, or a total area of 523,480 square feet, also four new passenger ferry slips and two new freight ferry slips.

Even with all this space every foot of wharfage along the waterfront is now occupied, and steps are being taken to hasten the completion of all work now under way, and to start on the new work, because, unless sufficient facilities of all kinds are provided soon, the port may be swamped with commerce.

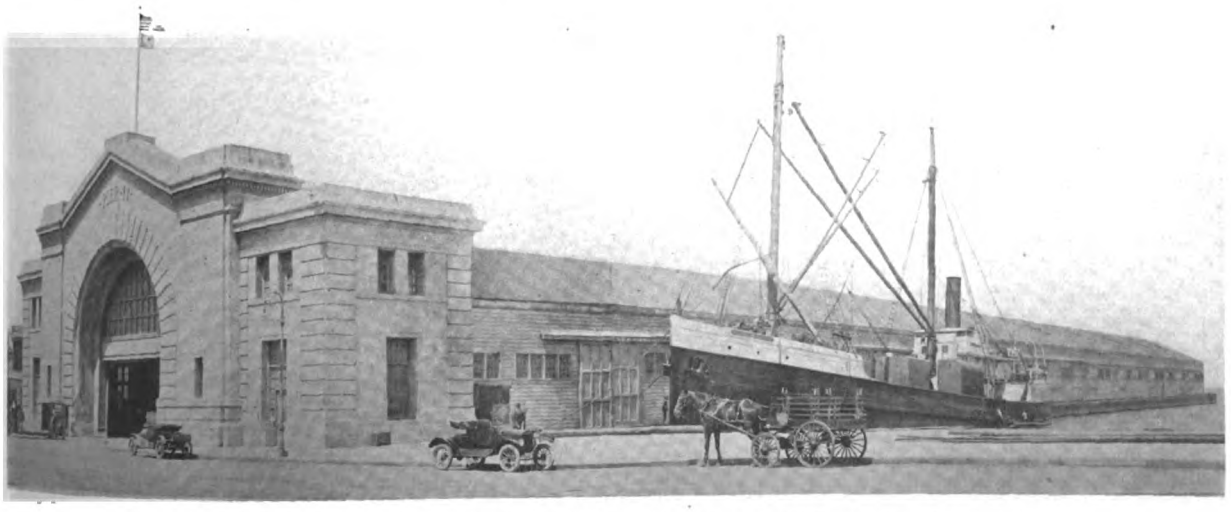

Fig. 2.—Type of Modern Pierhead Which Is Replacing the Older Construction

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Several important moves have been made recently by the Harbor Commissioners in the development of the port facilities to meet adequately the after-war conditions.

First, new plans have been completed for the immediate construction of bulkhead warehouse construction providing a chain of double-decked warehouses. This will mean establishing at least six of these structures between piers on the harbor north of Channel street. Estimates by the Board show that this additional cargo building space will be equivalent to the area of three new standard wharves 200 by 800 feet.

The programme for bulkhead warehouses designated the bulkheads between 39 and 41, 33 and 35, and 26 and 28 as the first three that will be used for double-deck construction. These are intended particularly for foreign trade. They will be equipped with the most modern cargo handling devices on both decks. Added to this is the single-deck warehouse now under construction between piers 31 and 29. Other points on the front where space can be used without cutting off the required berthing for ships will be utilized.

A special study was made by the engineers of desirable locations of these warehouses to which can be stevedored cargoes direct from the ship and there stored at the convenience of the importer. An arrangement will be made for the handling of this freight so that both incoming and export shipments may be moved with greater facility and with relief to the dock area in storing it. The plan will be extended as rapidly as needs develop. This programme is in line with plans which are the outcome of recent studies of the conditions with relation to possible recurrence of the freight congestion of last winter, and the needs of the port as developing with the new business expected to follow the declaration of peace.

These plans comprehend the extension of the present seawall along the front between the piers. The average extension from the seawall line waterward to get this additional space for warehouses will run approximately 150 feet, with the space between the docks to be thus connected varying from 200 feet. The plan of extending the bulkheads to give the space close to the docks will work out to better advantage to the state as well as to the commerce of the port by not increasing port charges.

In connection with these warehouses, plans have been completed for the immediate construction of three warehouses for foreign cargo in the landward side of the waterfront, connected with the piers by the belt line and such electric cargo conveyors as may be necessary to handle business for this warehouse programme. These structures will be of reinforced concrete construction, absolutely fireproof. The first of these warehouses will probably be six stories in height. The first site selected for these warehouses is seawall No. 4, in close proximity to docks which are now in overseas commerce use. This is already tracked for belt line service and is convenient for the handling of electric conveyors as may be required. This lot has an area of 20,000 square feet. The second warehouse will be built on lot No. 13, having an area of 27,000 square feet, and the third will be built on seawall lot No. 23, having an area of 88,000 square feet.

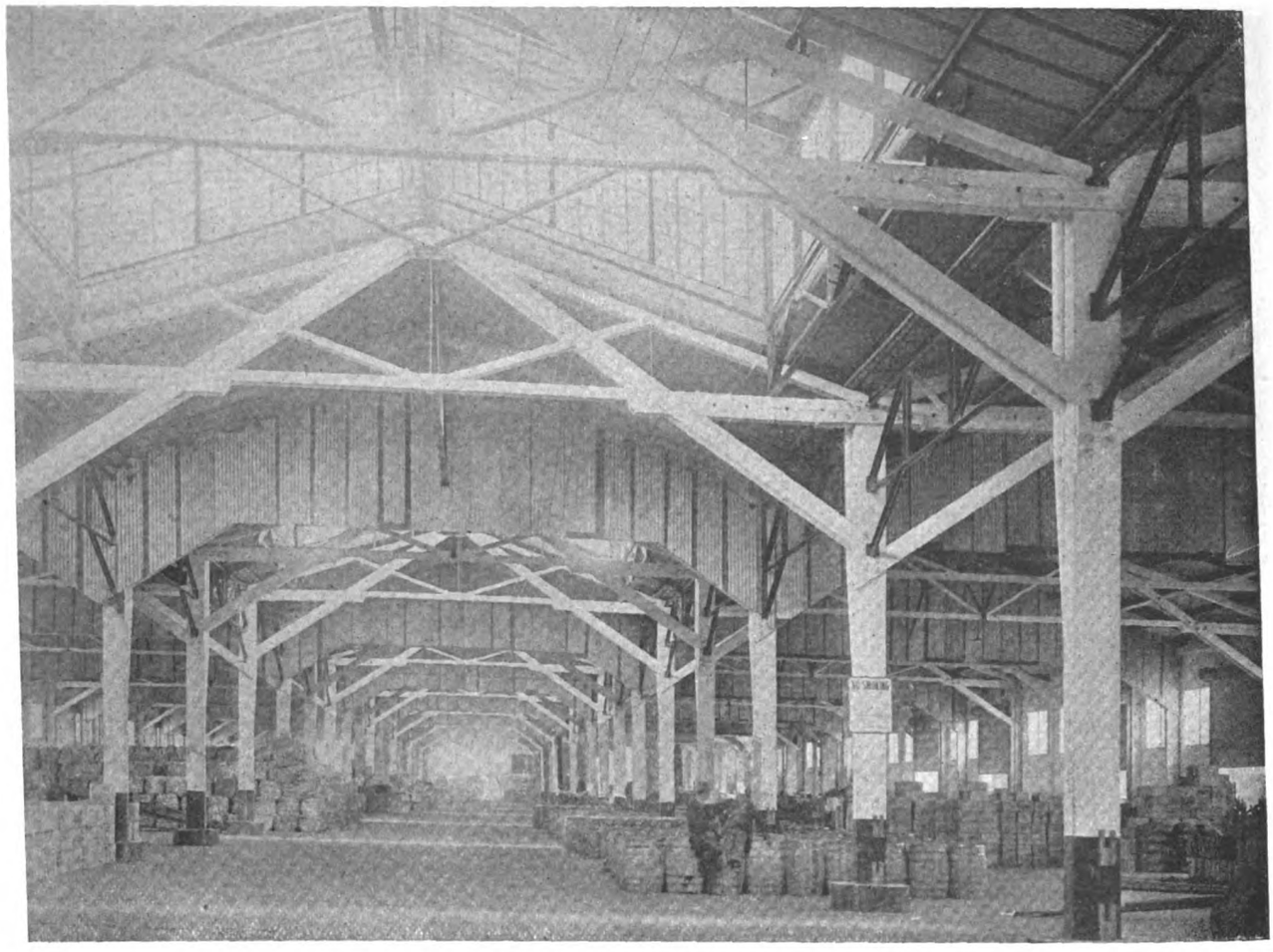

Fig. 3.—Interior Construction of Pier Shed with Spacious Proportions

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In order still further to bring the full area of the waterfront into use, the Board has let the first contract in a plan of pier extension, which will add hundreds of thousands of square feet to the cargo handling capacity of the port. The first extension is being made at pier 21, carrying that pier to the full length of 800 feet at the pierhead line. This work is a prelude to the further development of the piers to their full length, limited only by the United States Government pierhead line. Following immediately will be extensions of pier 25 from 600 to 800 feet, all north of the ferry. On the south side of the ferry, pier 20, the old United States Army transport dock, which was in service during the Spanish-American War, will be extended. This pier was the headquarters of the transport service to the Philippines, and it will be carried out 450 feet farther to the pierhead line, doubling its capacity for berthing and cargo uses. The Board carefully surveyed the piers, with a view of determining those that should be extended. The piers that will not be increased in area are such as have been determined upon as requiring replacement in a few years with more modern construction. The policy is to construct piers of fireproof material.

eliminating the geographical advantage of the northern ports with Asiatic ports, as against San Francisco—are comprehended in the installation of modern cargo handling equipment on the harbor docks. This is soon to be carried out by the Harbor Board. It is calculated that so much quicker dispatch will be given to ships in both loading and unloading that the amount of time saved will more than offset the comparative disadvantage which now handicaps the port due to the shorter route out of Puget Sound to the Chinese and Japanese ports.

The floating equipment privately owned, which can be rented by shipowners in San Francisco Bay, consists of five 20-ton floating derricks, with booms from 90 to 100 feet in length, one 30-ton floating derrick with a 60-foot boom, two 50-ton floating derricks with 100-foot booms and one sheer leg derrick with a capacity of 100 tons.

The Harbor Commissioners are completing plans for building the best-equipped terminal on the Pacific Coast for handling Oriental vegetable oils. The increase of Oriental oil imports has become so great, that the plans for handling of this oil consist of a $200,000 (£41,000) terminal at Islais Creek, and a tank barge to handle bulk

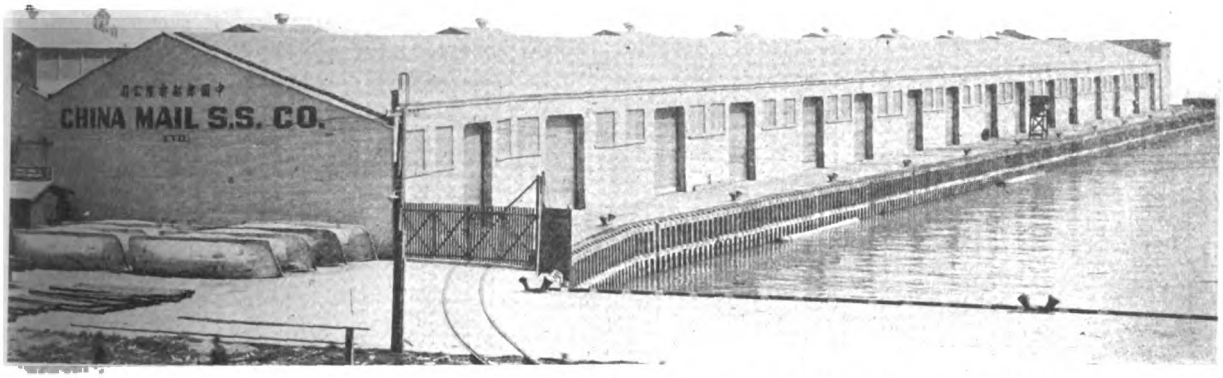

Fig. 4.—View of Modern Pier Showing Side Track and Frequency of Doors Opening into Shed

Pier 43 will be extended and widened to provide an additional 44,600 square feet of space for handling bulk cargo that can be loaded or discharged conveniently and economically without shed covering. The extension will be of irregular shape, ranging from 60 feet at the end of the present structure to 176 feet in width at its farthest projection in the bay.

Included in the plans for still further development is a project for a huge pier to replace No. 1, directly north of the ferry building. This pier will be erected immediately and will be used jointly by the California Transportation Company and the California Navigation and Improvement Company. Pier 1 will be 600 feet long, 138 feet wide and covered with fireproof shed, which will be supported by a reinforced concrete substructure and will constitute a second unit of the twin river steamer terminal. The pier will cost about $250,000 (£51,250) and the shed $150,000 (£30,700).

The plans for the construction work for all the contemplated improvements enumerated are in readiness, and the Harbor Board is taking steps to commence work at once, as the modifications of the building restrictions have removed the last barrier.

Reduction at the port of the cost of operation of cargo ships from the Orient and the cutting of the time in port for the loading and discharging of ships from an average of six days to four days on a round trip voyage—thus

oils from vessels. For the latter purpose the Board has recently purchased the tank barge *Mohican*, at a cost of $25,000 (£5,125). The barge has been equipped with numerous small tanks capable of handling, in all, 750 tons, and also with heating and pumping appliances to transfer oils from steamers that cannot shift conveniently from one pier to another.

For this terminal the state will set aside five acres of filled-in ground and the wharf lying at the south side of Islais Creek channel, west of the Third street bridge, accessible to large as well as small vessels. There is 30 feet of water there now, but the channel can be developed to such depths as may be necessary to berth as large ships as may be required. The point selected is within reach of the transcontinental rail lines.

The terminal will be equipped with the most modern equipment for discharging, storing, loading and handling vegetable oils in bulk, cases and in barrels. The wharf is to be entirely covered by an open shed, and the surface of the pier covered with liquid-proof covering set at a pitch which will permit the oil to be drained off and saved. The facilities are to include pipe lines, heating apparatus, loading racks, pumps, dumping tables and a heating room. On the five-acre lot will be built at least two public tanks, which can be utilized by shippers not prepared to utilize private storage.

Certain areas of the five-acre lot will be set aside for

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tankage, to be leased to private handlers of oils. These firms will build their own storage tanks, but use the equipment of the state in unloading from the ships into the storage tanks or cars.

When this terminal is completed it, combined with the various private plants in the bay, will provide for storage of nearly 50,000 tons. An oil terminal with a capacity of 8,000 tons was recently completed by the Philippine Oil Company, with an 8-inch pipe line leading to pier 38 for unloading oil from ships. This plant is now being extended, and when completed will have a capacity of 19,000 gallons.

What is probably the largest project ever contemplated by the Harbor Board is the development programme for Islais Creek and India Basin. The Southern Pacific, Western Pacific, Santa Fé and Ocean Shore railroads here come together at deep water in a manner not equaled anywhere in the state, and the advantages of this location could not be duplicated anywhere. This programme carries plans for the development of 160 acres or more of land, filled and submerged in the two basins comprehended in the joint treatment of the properties already in state possession and the small parcels of Islais Creek section yet to be acquired. There will be many miles of new dockage available to the port, as well as the establishment of a vast system of harbor facilities, which will provide for many years to come for the growing transpacific and domestic commerce of the port. As soon as the first units have been started, other units will be built which will involve improvements of the water and rail terminals extending from the channel to Hunter's Point.

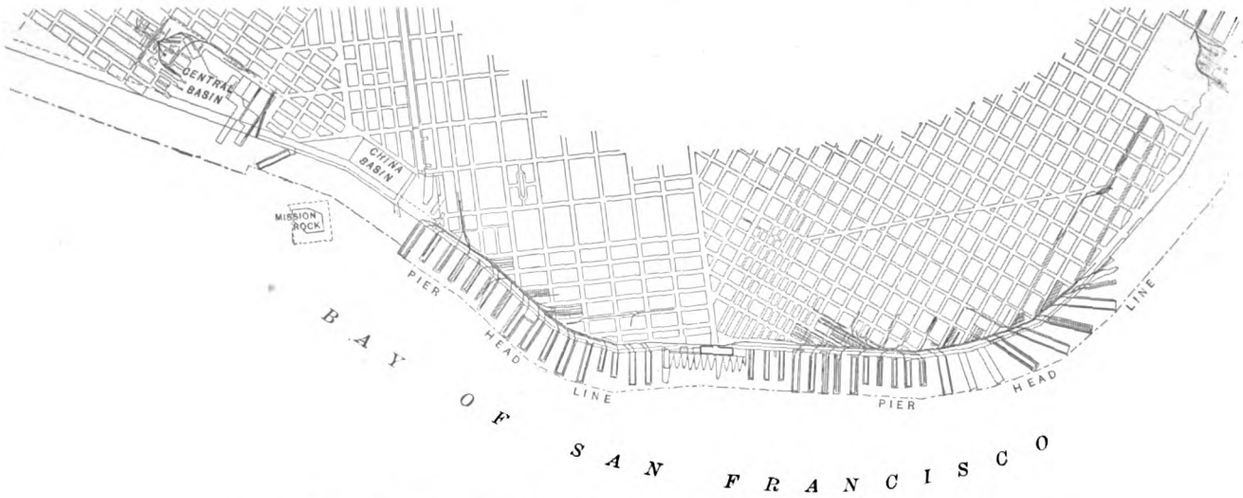

Fig. 5.—Plan of San Francisco Waterfront Showing Opportunities for New Developments

The channel which forms the main entrance to the basins is now equipped fairly well to handle considerable business, but it will be brought up to its full capacity as fast as business warrants. The channel will be widened 50 feet on each side. This will be done first up to the Third street bridge, in connection with the projected wharf construction on the south side of the channel. West of the bridge the same width will be established for the handling of the shipping which will dock between the bridge and the Southern Pacific Railroad trestle. At the present time a new wharf extends along the south side of the Islais Creek channel from the Third street bridge to the Southern Pacific trestle, a distance of about 1,600

Fig. 6.—Plans for the Development of the San Francisco Waterfront in the India Basin—Islais Creek Section, as Submitted by the Engineering Department of the Board of State Harbor Commissioners

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feet. A turning basin will be constructed in the channel west of the Third street bridge for use of smaller steam schooners and the craft which are using that part of the channel wharves.

On the south side of the channel, from the Third street bridge east, the 700-foot wharf, now completed, will be extended to 2,200, and later to 3,000 feet. From the outer end of this wharf a bulkhead will extend southerly, as seen in the architect's drawing, Fig. 6. Numerous piers, sheds and warehouses will be built. The slips will be 350 feet wide and ships of this length or less can unload directly into the sheds built on the bulkheads between the piers. The cargo can then be transferred directly to the warehouses seen just in front of these sheds, also extending between the piers. These will be connected with the railroads, bringing ships and rail together in a most efficient manner. In front of the warehouses will be built sidewalks and a street.

Included in these plans are coal bunkers for loading ships, and large docks for taking care of structural steel, coal, lumber, etc. These will be equipped with the latest equipment for handling the cargo.

The Harbor Board is unanimous in its opinion that the natural industrial growth is to the south. A great area in the basins will provide room for industrial expansion. A large rice mill was recently constructed west of the Third street bridge, and cargo conveyors are being installed, with facilities for docking cargo vessels in the channel. The site which will be utilized for industrial purposes is shown in Fig. 6.

The Board proposes to keep ahead of the demand and to anticipate the increasing call for harbor and industrial space. The general programme of development will be followed along progressive lines now being worked out by the engineers. When the piers now under construction north of Channel street are completed, all available space where piers could be constructed north of Channel street will have been exhausted, and new construction must be confined at Islais Channel, India Basin and China Basin.

Maintenance and Repairs

Coincident with the large increase in the harbor facilities and in the tonnage handled, the work of maintaining the property under the jurisdiction of the Board of Harbor Commissioners has also very largely increased. An efficient maintenance and repair department has been constantly at work, and all structures have been kept in good operating condition. While most of the work was done by the maintenance and repair department, some of the larger jobs were done by contract.

The development and extension of the State Belt Railway switching system have kept pace with pier development, and San Francisco undoubtedly now has one of the most complete harbor belt line railroad switching systems in the country, there being approximately 40 miles. The railroad is located on The Embarcadero, a marginal thoroughfare 200 feet wide, located just behind the seawall, and the system is intended and is used to connect up the various piers, the yards of other railroads and private warehouses and industries generally.

It has been the policy of the Harbor Board not only to equip all new piers with spur tracks running the full length of the piers, but also, wherever the water slip spaces beside the old piers were sufficiently wide to permit of it, to widen existing piers and place spur tracks thereon. Where there are tracks on both sides of the pier, the usual practice is to make one a surface track, and the other is depressed so as to bring the floor of the railroad car on a level with the floor of the pier, thus facilitating trucking of certain classes of freight. The practice is to accommodate the proposed tenants in this regard according to their preferences.

It was a practice of former years to install railway spurs down the center of the pier. But experience has demonstrated that the center arrangement is a mistake, because it interferes very seriously with teaming and trucking. The placing of the tracks along the sides of the piers, outside the sheds, is now universally demanded by shippers. This arrangement has been followed in all recent constructions.

Belt Line Facilitates Freight Movement

By recent construction and extensions, a continuous belt railroad switching system, adequately equipped, is now in full and successful operation around the whole active harbor front of San Francisco, from the Presidio on the north and west to Channel street on the south. It is a tremendous gain to the harbor, and its real advantages only become properly estimated when it is recollected that even such a great seaport as New York has no harbor belt line.

Street improvements upon The Embarcadero and other neighboring streets under the Board's jurisdiction have also been vigorously prosecuted. All the expense of constructing, maintaining, cleaning and lighting the harbor marginal street comes on the Harbor Board. To assist in policing and patrolling, flood lights and projectors have been installed at advantageous points so as to light the sides and ends of piers. The efficiency of the electrical department in safeguarding the waterfront against disastrous fires has been increased by the appointment of an experienced fire marshal and by the installation of fire-fighting apparatus.

For the purpose of obtaining data on the construction and operation of harbors, the Harbor Board sent Frank G. White, chief engineer for the Board, on an inspection trip to the principal ports of the United States and Canada. He visited the most important ports on the Pacific and Atlantic coasts, as well as on the Great Lakes and the Gulf of Mexico, and obtained many new ideas now being used in the operation of San Francisco Harbor.

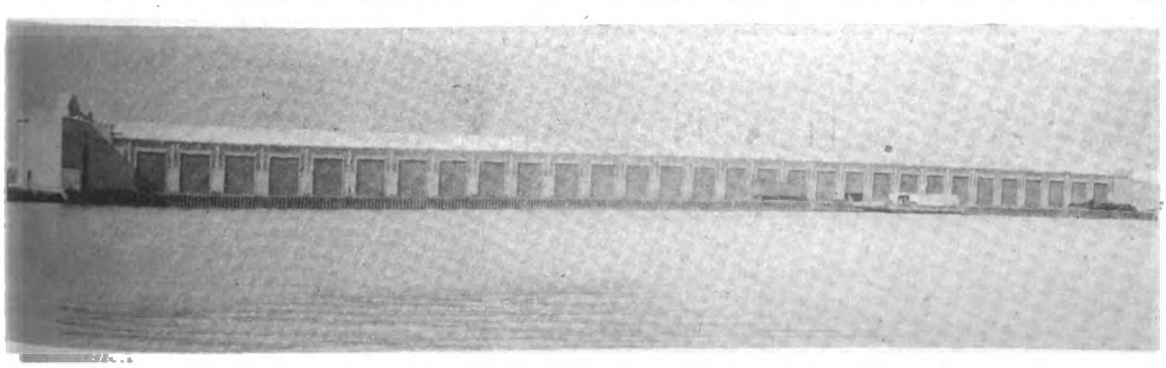

Fig. 7.—View of Long Pier Recently Built Which Incorporates the Newer Ideas on Pier Construction

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Design and Construction of Producer Gas Power Lighter

Special Central Control for Engine and Hoisting Apparatus—Double Rudder Installation—Compact Engine Room Planning

BY FREDERIC S. NOCK*

THE plans are those of a power lighter designed and built by Frederic S. Nock, East Greenwich, R. I., for James A. Potter & Company, of Providence. This craft was built to carry lumber in Narragansett Bay and was developed along lines that were considered most practicable for the purpose. The question of draft was a prime factor, as was also the ability to carry a maximum load at a given speed. The lighter is installed with two gasoline engines, each of 50 horsepower, and a Galusha marine gas producer burning Chinese anthracite. When

Fig. 1.—Producer Gas Power Lighter Designed to Carry Lumber

it is required to operate the hoister, upon arrival of the lighter at destination, one engine is stopped, the clutch between the other engine and its propeller wheel disengaged, and another clutch in front of this engine thrown in. This connects the propelling engine to the hoister, with both engine and hoister controlled and operated from the pilot house. The drive from the starboard engine to the hoister is by means of bevel gears.

On the main line of shaft there is a sprocket operating a winch on the starboard side of the pilot house for handling the vangs of the boom, etc. The hoisting of the boom and handling of deck loads is done through controls operated in the pilot house. Pilot house control is also provided for handling main engines when the lighter is under way.

The hoisting apparatus was made by the Coulter & MacKenzie Machine Company, Bridgeport, Conn. The gas producer is placed in aft of the engines. The producer room is separated from the engine room by a bulkhead, and access to this is accomplished through two sliding doors.

Ample room is provided over the producer for the attendant to poke down the coal, etc. The engine room is large and well ventilated and contains, besides the propelling units and hoisting apparatus, auxiliary pumps and a direct connected generating set for electric lights. Ample ventilation and light have been provided for all rooms. Partitions between the producer and the engine rooms, as well as the living quarters, are double, with roofing papers between the two thicknesses.

TIMBER AND SCANTLINGS FOR 70-FOOT LIGHTER

Bilge logs	6 inches by 8 inches
Rake timbers	6 inches by 8 inches
Deadwood	Sided 6 inches
Frames	4 inches by 12 inches
Clamps	4 inches by 12 inches
Keelsons	6 inches by 8 inches
Deck beams	3 inches by 8 inches
Heavy deck beams	6 inches by 8 inches
Bulkheads	3 inches
Planking	3 inches
Deck planking	3 inches
Bumpers	10 inches by 12 inches
Bumper backing pieces	10 inches by 14 inches
Bitts	10 inches by 10 inches
Braces and diagonals	4 inches by 8 inches
Fenders	4 inches by 8 inches
Knees and quarter braces	8 inches thick
Spikes	3/8-inch by 7 inches and 3/8-inch by 8 inches
Edge bolts and fastenings	3/4-inch diameter iron rod

The space over the engine room offers living quarters for the engineer and captain. It comprises two berths on the starboard side, a large clothespress, a toilet at the after end of the port side, lockers, dresser, shipmate range, table, sink, etc.

Owing to the amount of dead water carried at the stern

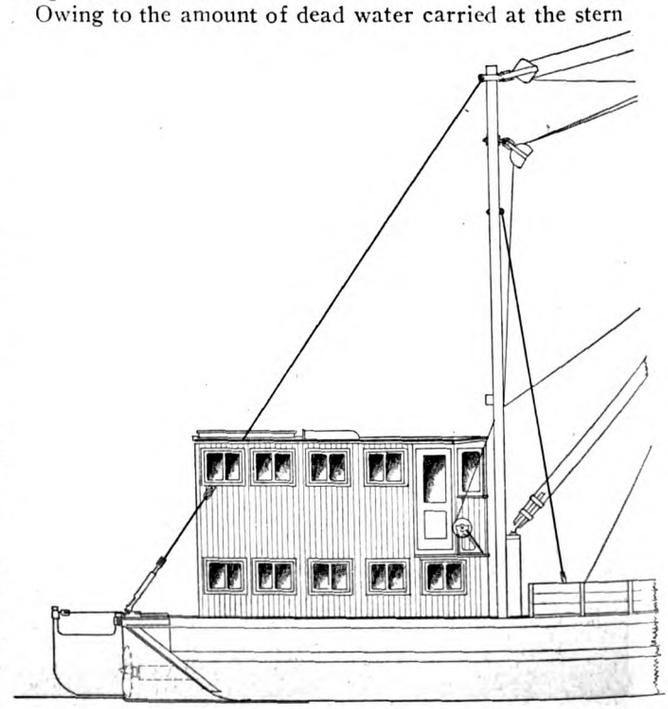

Fig. 2.—Showing Arrangement of Pilot House, Derricks and Propeller

of this type of self-propelled lighter, double rudders are used instead of a single rudder amidship. These, operating in live water, have proven much more efficient than the other design.

* Naval Architect, East Greenwich, R. I.

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While the "A" frame and boom were not required to raise heavy loads, ample provision has been made to secure a high factor of safety. The after guys of the "A" frame are 1-inch diameter crucible steel wire rope, and the forward guys ¾-inch diameter. The iron work for the "A" frame and boom is also of ample dimensions. The plans show the boom rigged with double pawl hoist, but for ordinary work in loading a single line will be used. This will expedite the handling of the deck load.

Heavy Carrying Capacity

The lighter has carried a deck load of 120,000 feet of yellow pine to the forts in the lower bay. Which will give some idea of the carrying capacity of the 70-foot lighter of this type.

General Dimensions and Construction

Length overall	70 feet
Breadth at deck	21 feet
Breadth at bottom	20 feet
Depth, bottom to upper side of deck	5 feet 2 inches
Depth of hold	4 feet

The operating cost of this lighter is small, since the engineers for the hoister and the lighter crew also attend to the propelling machinery. The 100-horsepower plant, running full power for 10 hours, consumes but one-half ton of coal, costing about $5. A steam plant doing this same work would require two and one-half to three tons of coal, costing $25. To run the same engines on gasoline would mean using 130 gallons, costing about $35. Investigation shows that the first cost, fuel cost and also the upkeep cost of fuel oil engines would be much higher.

Palmer Brothers Engine Company, of Cos Cob, Conn., furnished the two 50-60 horsepower engines, each of which has four cylinder 7½-inch bore by 10-inch stroke, turning from 300 to 400 revolutions a minute. The 100-horsepower Galusha Marine Gas Producer was built by the Nelson Blower & Furnace Company, of Boston, Mass.

This lighter was put into active commercial use in September, 1918, and is used to transport lumber to Newport, R. I., from the Providence, R. I., plant of James A. Potter & Company.

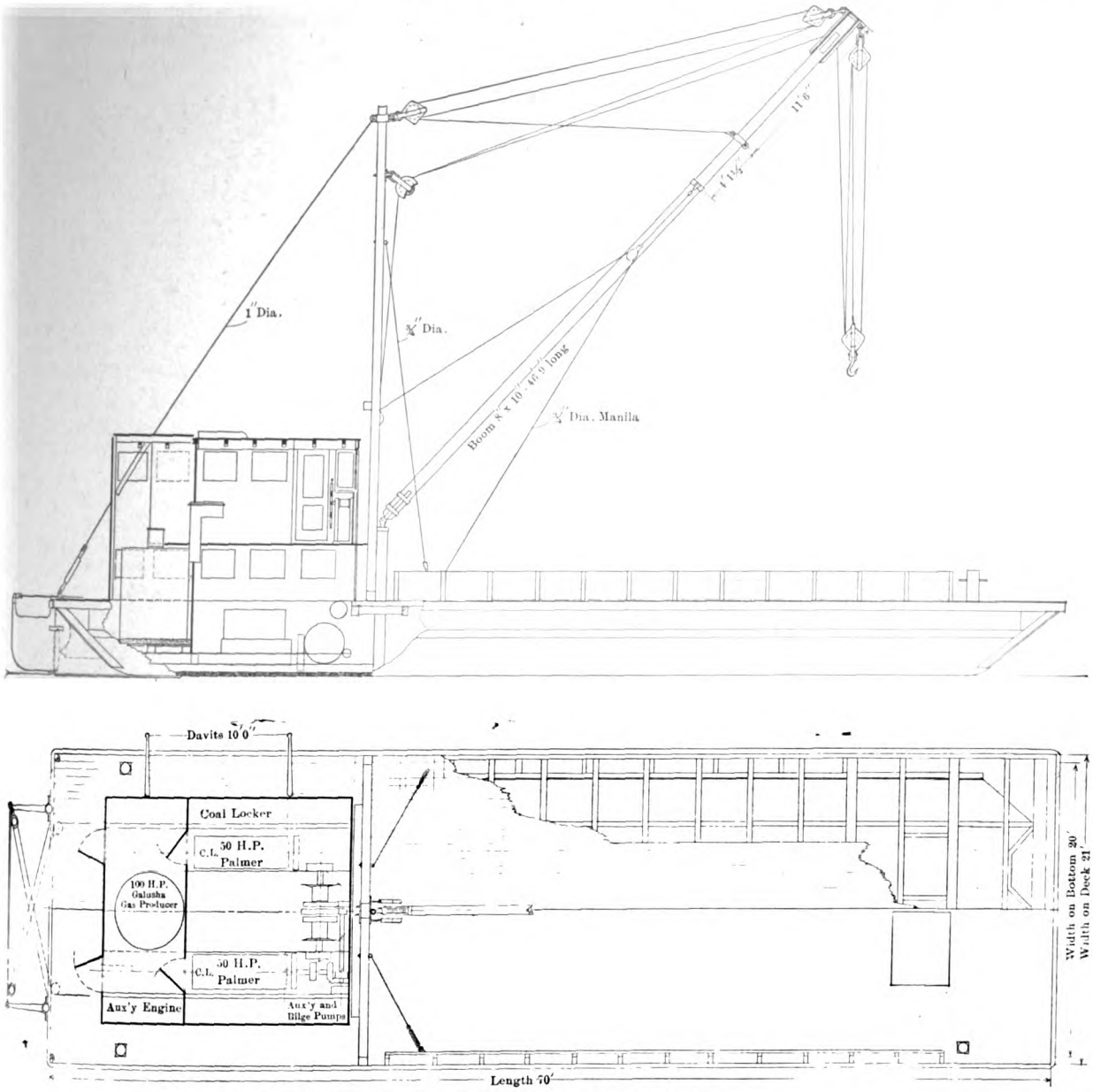

Fig. 3.—Profile and Plan Showing Engine Installation

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Fig. 1.—Training Department (Director and Instructors) of the Submarine Boat Corporation

Training Workers for the Shipyards†

Short Cut Over Old Apprentice System—Work Progresses from Simple to Difficult Operations—Rivet Records Show Results

BY R. V. RICKORD*

THE education and training section of the Emergency Fleet Corporation, known in its embryonic stages as the industrial training department, has been in operation for twelve months. The work of the section consists partly in placing at the disposal of the various shipyards facilities to enable them to do a systematic and thorough job in the training of shipyard mechanics, and partly in conducting other features, such as the distribution of electric welding information and the training of men for the higher marine engineering positions. The policy adopted by the Emergency Fleet Corporation in the matter of trade training has led to the creation of a new trade in the shipyards, namely, that of instructor, and one of the first jobs which presented itself was that of supplying a basis on which to build up this new trade.

Fig. 2.—Learner Doing an Easy Snap Job on the "Farm"

When the Emergency Fleet Corporation was quite young, Admiral Bowles foresaw the difficulty connected with the breaking in of new men and the danger lurking in any promiscuous or old-time scheme, such as that in not only taking an unduly long time to make the required mechanics but also in turning them out in "half-baked" condition. While the shipyards were following up the scheme of breaking in men by placing them on the vessels as helpers, the study of how most efficiently to teach men trades had been going on for years by various interested authorities in institutional, municipal and university undertakings. It was from men of this type that Admiral Bowles sought advice and help. The result was the creation of a staff of expert trade teachers, each one of whom

Fig. 3.—A Job in the Air to Enable Learner to Acquire "Nerve" for Driving at Great Heights

* With Education and Training Section, Emergency Fleet Corporation.
† Photographs by Publishers' Photo Service.

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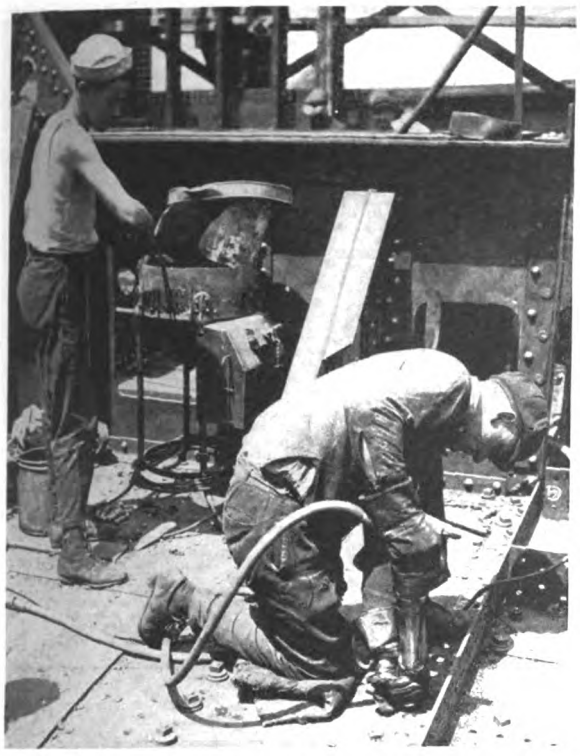

Fig. 4.—The Next Job in Order of Difficulty

was an expert tradesman as well as an expert teacher, and whose job it was to convert an expert shipyard tradesman into a man of his own type, so that the tradesman could break in new men with a thorough working knowledge of the trade in the shortest possible space of time.

A definite scheme of study for prospective instructors was hit upon. Each instructor has had to go through the "dope," as the shipyard men popularly call it. No one has been certified as being qualified for the work of instructor unless he has satisfied the Emergency Fleet Corporation

Fig. 5.—Learner Doing Advance Work of Flush-Riveting on Vessel

that he can handle a group of green men and instruct them properly.

After a year's efforts a large proportion of shipbuilders all over the country have, with the co-operation of the Emergency Fleet Corporation, installed Training Departments, and in District No. 2, with which this article mostly deals, almost 100 percent have recognized the superiority of the new method by installing the training departments recommended by the corporation. The figures showing the number of instructors trained and in training by the Emergency Fleet Corporation for the various steel yards in the district are as follows: Bayles, 9; Downey, 30; Federal, 22; Newburgh, 20; Standard, 10; Staten Island, 9; Submarine, 120.

No difficulty has been experienced in holding the tradesman's interest in the new undertaking. It may, indeed, be said that his efforts along instructional lines are quite extraordinary. He is called upon to make very extensive efforts during his six weeks' training period in learning how best to teach his trade, and this has the effect of so arranging the various details and aspects of the trade in

Fig. 6.—Learner Finishes by Doing Most Exacting Work That Can Be Expected of Him

his mind that the yard training department has frequently found itself face to face with the fact that no sooner has he been trained as an instructor than he has immediately been pressed into service as a foreman.

As soon as the embryo instructor begins to analyze his trade for instructional purposes, he sees it in an altogether new light, and the new purpose becomes magnified. He picks out a series of representative jobs and gives these to the learner, being sure that the learner has thoroughly learned one representative job in the trade before proceeding to the next. In other words, a smoothness of progression is obtained by starting the learner with the easiest job and proceeding gradually with the harder jobs until the most difficult job that he can be expected to do is given him.

The riveting jobs shown in the illustrations serve to explain this. Beginning with Fig. 2, the learner is shown doing the easiest kind of snap-head riveting on the "farm"; then the same kind of work on a vessel in an easy position; then doing a somewhat more difficult job—flush-

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riveting on the deck of a vessel—and after this, higher and more difficult positions, until, later, the more exacting flush-riveting work, and finally doing what is probably the most particular work on the ship that can be expected of him, namely, flush riveting on the shell of the vessel. The instructor is with the learner most of the time and follows him through all these jobs while in training, and in doing

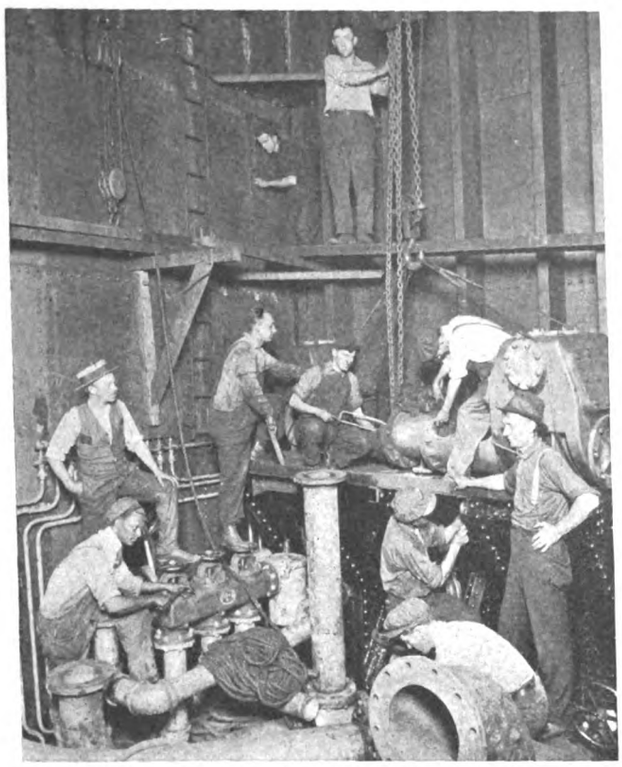

Fig. 7.—Installing Machinery

this can break in from four to ten new men at a time. All the work of training is done on the vessels or in the shops, so that every effort counts towards the completion of the ship, although the primary object of the instructor is not to produce ships but to produce new tradesmen.

The remarkable records accomplished by men who have come from the training departments of the various shipyards only one to three months previously are probably due to the thoroughness with which all the steps in the trade are taught. The most difficult job a man can do is comprised of the many minor jobs he has done previously, so that having learned the previous jobs thoroughly he finds no difficulty in doing the many small jobs which make up the big one. The riveting records of a few men from one yard taken at random will be of interest. The trades given are the former trades of the men and the records are those per day of ten hours. The yard had a riveting average of about 300 rivets per gang per day, and the men's records, after the men had been transferred from the training department to the production department not longer than three months previously, were as follows:

RECORDS OF WORKMEN

Previous Trade or Business	Number of Rivets	Size of Rivets
Auto mechanic	440	⅞ flush rivets
Rock driller	1,808	¾ " "
Cowpuncher	900	¾ " "
Laborer	720	¾ " "
Policeman	640	¾ " "
Broker	650	¾ " "
Holder-on	850	¾ " "
Helper	950	¾ " "

A study of the pictures given here of these men will serve to bring out the type of men desirable upon which to build the training. The training problem, and the finding of suitable men, touch upon the proposition of maintaining and even upbuilding the whole status and quality of workmanship of the shipyard worker. If new men are to be broken in at all, it is of the utmost importance, whether viewed from the standpoint of shipyard management, trade union, or individual worker, that the job be thoroughly and systematically done, otherwise the result would be a tendency to lower the standards of the various shipyard trades rather than to raise them. The training department in the shipyard, as organized by the Emergency Fleet Corporation, takes upon itself not only the work of training the man, thus relieving the executives and foremen of the necessity of having to give the time, which most of them can ill spare, to the breaking in of new men, but it also undertakes the responsible task of turning a man over to production only when he can be placed on the job and trusted to do the work himself without having to be a source of constant anxiety to the foreman under whom he happens to be placed. Of course, there is an alternative. It is that if it is not possible to train an individual in the training department, by reason of his own inability, so that he cannot be turned over to the production department as a thoroughly trained individual, then it is to the best interest of everyone concerned to drop him.

The organization of a training department is such that one individual is responsible for all the training that is done in the yards. The job of this man is really that of "foreman of training," and he is responsible for the mak-

Fig. 8.—Representative Group of Shipyard Workers—Former Cowpuncher, Old-Time Policeman, a Former Auto Mechanic, a Laborer, a Farm Hand, Rock Driller, Holder-On—Now a Riveter, a Former Broker, a Former Helper

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Fig. 9.—Calking

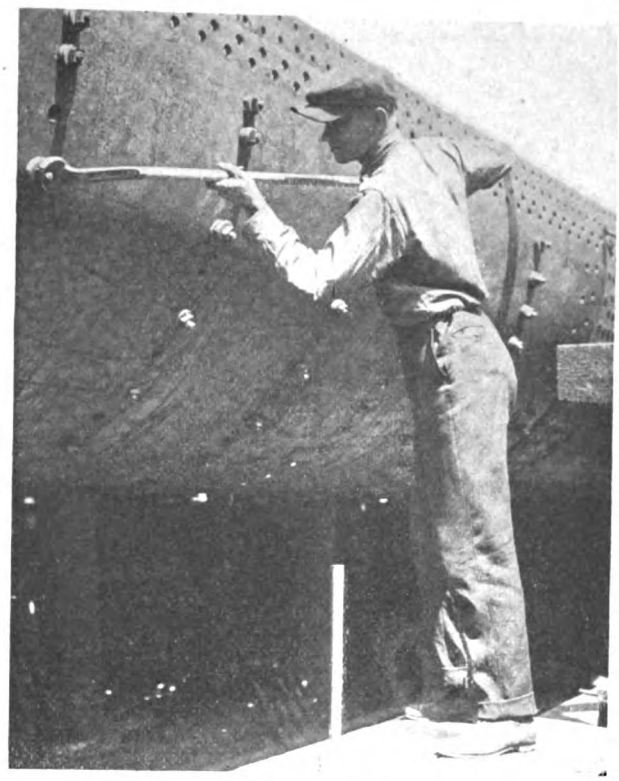

Fig. 10.—Bolting

ing of tradesmen out of "green" material. He works and co-operates with the various foremen in the yard, but not under them. He obtains from them all the work to be given to the men in training, and is responsible for the correctness and quality of the work. The separation of the training work from the ship work as ordinarily supervised by the foremen is due to the difference in the nature of the job. The men who do the training must have the opportunity to do their work without scampering through it, which is very difficult when done under pressure of the production department.

The ideal arrangement in the establishment of a training department is one in which the department "heads up" under a superintendent or manager who has sufficient sym-

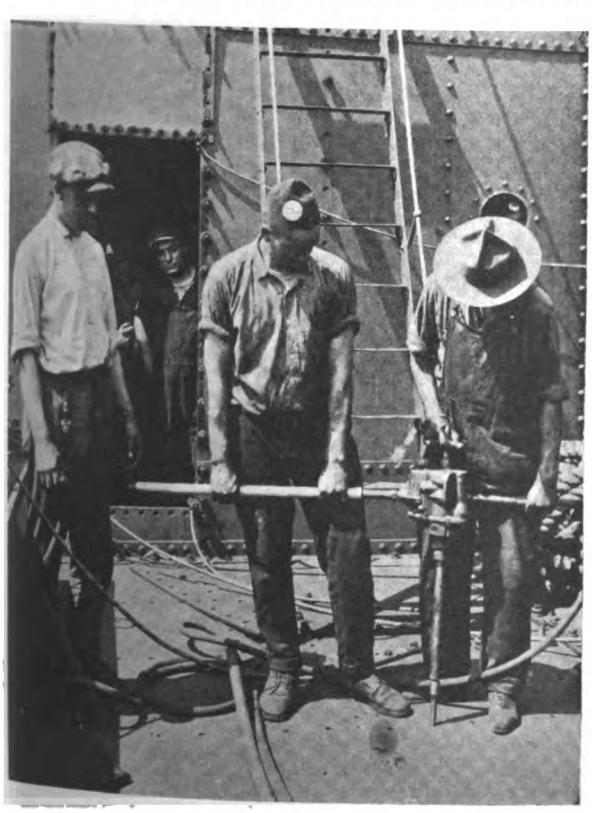

Fig. 11.—Reaming

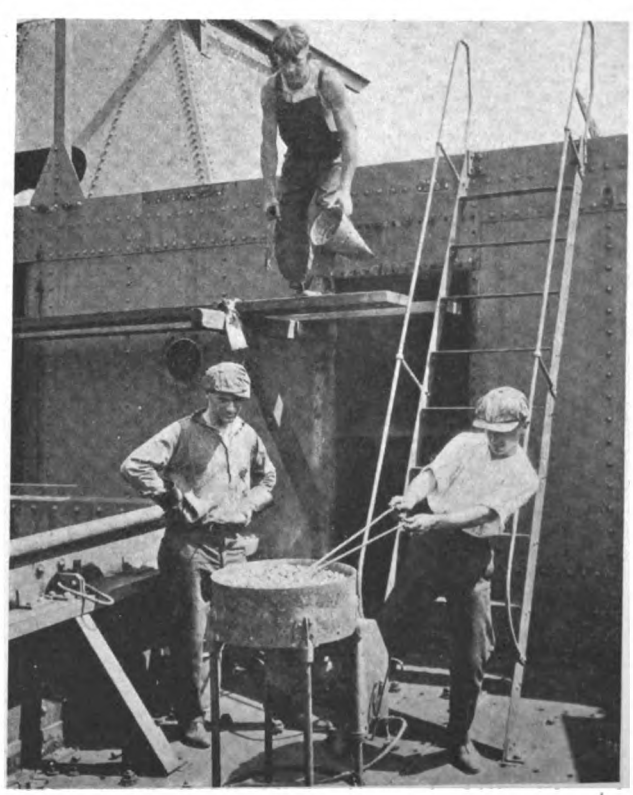

Fig. 12.—Heating

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pathy for the movement, or desire for a proper trial, to bring about full co-operation between the training department and the production departments. This type of man obtains for the training department all the work on the ships and in the shops that may be necessary to enable the department to fully instruct all the learners it has on hand. Also he will give instructors sufficient time and encouragement to enable them to instruct the learners properly and in accordance with the arrangements laid out, and in which they have been introduced, by the Emergency Fleet Corporation. The placing of the training department under the proper individual superintendent or manager in the yard, in order that the proper co-operation and encouragement is obtained, probably has more to do with the successful working of a training department than any other item.

The importance of the yards now having systematic training arrangements can be gathered from the list given previously. The managements of some of these were openly doubtful when first approached on the subject as to the results. At the present time, however, not only have they expressed satisfaction, but in several cases have asked that a Fleet Corporation staff instructor be sent to their yard for the purpose of training more instructors to take care of the expansion in the training departments. Under the circumstances it is hardly necessary to make further statements as to whether the steel shipyards in the Emergency Fleet Corporation consider the training done with the co-operation of the Emergency Fleet Corporation to be more efficient and quicker than that done by the old method of placing the man in the yard as a helper and letting him pick up the trade as best he can, or by the apprenticeship method, which depends upon the personal willingness of the foreman or individual workman to show the man how to do the job, a system which tends to spread the process out over a period of several years.

Electric Welding in Ship Construction*

Methods of Welding and Apparatus Described—Inspection and Testing the Welds—Speed and Cost of Welding—Lloyd's Experiments

BY H. JASPER COX

TWO methods of electric welding are applicable to ship construction—resistance welding and arc welding.

Resistance welding may be applied in two ways—spot welding or butt welding. Spot welding has been extensively used for jointures of thin steel metal, such as ventilators, lifeboats and railway cars, with considerable success, but it is only recently that its application to thick plates and bars of the thickness required in ship construction has been investigated.

Spot Welding

The two or more pieces to be welded are overlapped or superposed in way of the joint and clamped between two copper electrodes; the current is passed through and pressure applied. In order to ensure a successful weld, the pressure should be sufficient to cause the metal to "flow" at the weld and to extrude all oxides, slag, etc., which may form. The pressure is maintained for a short time after the current is cut off, and the operation is then repeated at the next spot, and so on.

Small buttons or disks of metal are sometimes placed under one or both of the electrodes, and when of proper thickness are completely submerged in the plate metal during the operation of forming the weld.

As in smith welding, we cannot see what is going on at the welding surfaces, and, although the material may have been properly prepared, the success of the operation obviously depends upon:

(1) The amount of current applied to produce the proper heat throughout the various stages of the operation.

(2) A sufficient pressure to weld the surfaces and extrude oxides, gases, etc., without undue distortion of the material.

(3) Sufficient time being allowed.

(4) The size and type of electrodes used.

In light work these variables have to a great extent been determined by extensive practice and experience, but in the heavier material used in ship construction there has until recently been little or no experience available. However, the advantage of successful application of this method of uniting material to the exclusion of marking off, punching, reaming, countersinking and riveting in the fabrication shops and even on the ship itself are obvious. It is also patent that if the quantitative values of the above variables necessary to produce a perfect weld are definitely determined for all thicknesses of material, the operation becomes not only entirely mechanical but also uniformly efficient.

Intensive research work is now being conducted along these lines by the General Electric Company, who have built a heavy spot welding machine with a capacity of 100,000 amperes at 20 volts and a hydraulic pressure of 36 tons at the electrodes. A careful series of experiments is being carried out with this machine, using plates of from ¼ inch to 3 inches total thickness, and it has already been demonstrated that satisfactory spot welds can be made within this range.

It has been found that an appreciable range is permissible in the variables of current, pressure and time without seriously impairing the efficiency of the weld for a given thickness of material. Where considerable *tensile* pull is anticipated in an overlap joint, it is considered desirable to have a double row of spots to prevent the tendency to bend and tear out the spots in the same manner as the countersunk heads of rivets are sometimes torn through the holes in a single-riveted overlap.

The 46-foot section of a 9,600-ton vessel to be built at the plant of the Federal Shipbuilding Company, Kearney, N. J., will be used to demonstrate the practicability or otherwise of this method of welding as applied to the assembly of material in ship construction. A stationary spot welder will be used in the fabrication of the parts, and a large 60-inch gap portable spot welder is being

* Paper read at the twenty-sixth general meeting of the Society of Naval Architects and Marine Engineers, Philadelphia, Pa., November 15, 1918.

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completed which will be used both for clamping the parts together in the field and spot welding them in place.

It will be seen, therefore, that, although this method of welding has not yet reached the stage of development which might warrant its practical application to ship construction, it offers every prospect of doing so within the very near future. Obvious developments with this system are multiple spot and continuous or seam welding, both of which will tend towards great saving in time. In

Fig. 1.—Electric Arc Welding Shop at the Submarine Boat Corporation Plant

general, spot welding is much more rapid than arc welding and requires less labor, but more power and a much heavier and more expensive machine.

Butt Welding

This system of resistance welding is especially applicable to bars of uniform section and will probably have a large future in jointing the reinforcements in ferro-concrete construction.

The bars to be welded are brought together, end on, clamped and a low pressure current passed through until a welding heat is obtained. Then end pressure is applied until the metal at the joint shows signs of squeezing out. A machine for this type of welding has been ordered by the Emergency Fleet Corporation and will be tried out during the construction of a 3,500-ton (deadweight) reinforced concrete steamer building by the Fougner Concrete Shipbuilding Company.

Electric Arc Welding

The two principal methods of applying electric arc welding are by means of: (a) the carbon arc; (b) the metallic arc. The main field of application of the carbon arc method is in rough cutting in foundries and steel mills and for the repair or building up of imperfect castings. It has not been advocated for use in ship construction generally, and there are a number of reasons which make it doubtful whether it ever will be. In metallic arc welding, however, a metal electrode is used of approximately similar material to that being welded, the electrode itself is fused by the arc, and molten particles are carried over the arc into the fused portion of the parent metal, thus gradually building up the joint. The actual operation, however, is not quite so simple as this sounds, as there are a large number of variables, any one or any combination of which may affect the efficiency of the result to a greater or less extent.

These variables may be enumerated as follows: (1) The type of electrode, *i.e.*, bare metal or covered; (2) chemical composition of the electrode; (3) chemical composition of metal being welded; (4) size of electrode; (5) kind of current, *i.e.*, alternating or direct; (6) amperage and voltage; (7) skill of the operator; (8) method of preparing and building up the joint.

In regard to the first, it may be said that good welds have been produced by either, but the covered electrodes have been found to produce, in general, a more ductile weld, a very desirable quality in ship construction. The chemical composition of the electrode is to-day considered to be a most important variable, and after an exhaustive series of tests the Welding Committee has drawn up the following tentative specification for electrodes intended to be used in welding mild steel of shipbuilding quality:

Chemical Composition.—Carbon, not over 0.18 percent; manganese, not over 0.55 percent; phosphorus, not over 0.05 percent; sulphur, not over 0.05 percent; silicon, not over 0.08 percent.

Sizes.—

Fraction of inch	Pounds per foot	Foot per pound	Pounds per 100 feet
1/8	.0416	24	4.16
5/32	.0651	15.35	6.51
3/16	.0937	10.66	9.37

Allowable tolerance .006 plus or minus.

Material.—The material from which the wire is manufactured shall be made by any approved process. Material made by puddling process not allowed.

Physical Properties.—Wire to be of uniform homogeneous structure, free from segregation, oxides, pipes, seams, etc., as proven by micro-photographs. This wire may or may not be covered.

Workmanship and Finish.—(a) Electric welding wire shall be of the quality and finish known as "Bright Hard" or "Soft Finish." "Black Annealed" or "Bright Annealed" wire shall not be supplied. (b) The surface shall be free from oil or grease.

Tests of Arc Welding

Tests.—The commercial weldability of these electrodes shall be determined by means of tests by an experienced operator, who shall demonstrate that the wire flows smoothly and evenly through the arc without any detrimental phenomena.

Further reference emphasizing the importance of this

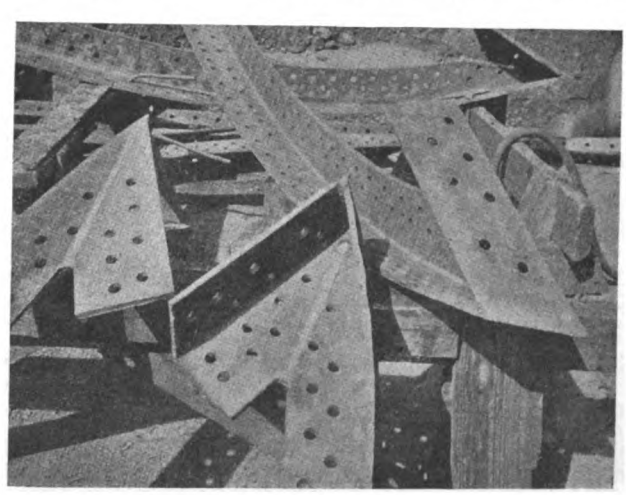

Fig. 2.—Elimination of Angle Smith Work in Watertight Floor Boundary Angles

factor will be found later under the Rules of Lloyd's Register of Shipping.

The chemical composition of the material to be welded is a quantity over which we have no great control, but open hearth mild steel of the quality under consideration

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has generally sufficient uniformity in its chemical composition to permit a general application of the foregoing specification. However, the effects of varying carbon and other contents, including occluded gases, are being carefully investigated with a view to obtaining a more complete knowledge, and it is considered that a true understanding of the successful arc weld will result only from a combination of metallurgical and electrical study.

The size of the electrode in relation to the current

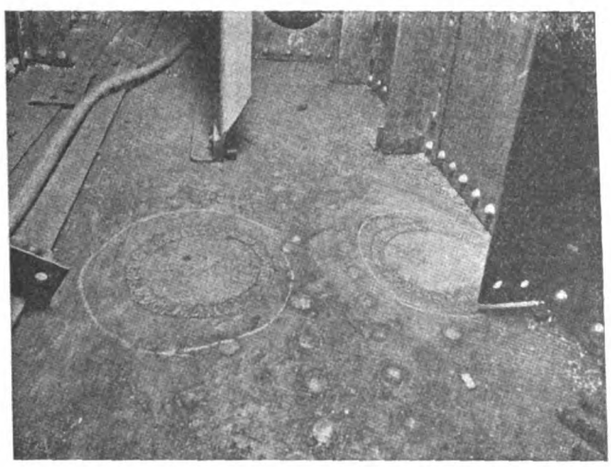

Fig. 3.—Misplaced Pipe Holes in Inner Bottom Plating Welded in 3½ Hours, Using 3 Pounds of Base Electrode

strength and the thickness of material to be joined is also a matter of obvious importance. While it has not yet been thought expedient to standardize these relations, the following table, published by the Quasi Arc Weltrode Company, may be found of interest:

ELECTRODES AND CURRENT REQUIRED FOR SHEET AND PLATE WELDING

Thickness of Work	Preparation of Joint	Size of Electrode Inches	Current in Amperes
16 S. W. G.	Close oint	.08	20 to 25
14 S. W. G.	Close oint	.105	30 to 35
12 S. W. G.	Close oint	.105	40 to 45
10 S. W. G.	Close oint	.135	50 to 65
3–16″ plate	1–16 open	.135	75 to 95
1–4″ plate	Veed half-way through and 1–32″ open	.16	93 to 110
5–16″ and 3–8″	Veed right through to 70° and 1–16″ open.		
	Two runs are necessary—		
	First run	.135	75 to 85
	Second run	.16	93 to 110
1–2″ plate	Veed right through to 60° and 1–8″ open.		
	Two runs are necessary—		
	First run	.135	75 to 85
	Second run	.192	100 to 120
5–8″ and 3–4″	Veed right through to 60° and 1–8″ open.		
	Three runs are necessary—		
	First run	.135	75 to 85
	Second run	.16	95 to 110
	Third run	.16	100 to 120

For heavy plates it is advisable to vee half way through from both sides if practicable. The current varies to some extent with the thickness of plate and type of electrode, bare electrodes requiring a higher amperage than covered. The kind of current, whether alternating or direct, has occasioned considerable controversy, and, while a direct current of a given open circuit voltage will permit of a slightly greater length of arc, the advocates of the alternating current claim that, since proper fusion depends upon the maintenance of a short arc, alternating current is preferable, as the arc itself will break if lengthened too much. As, however, efficient welds can be made by either, the question is more one of economy, ease of operation and convenience in the supply of current.

The amperage should be adjusted to suit the size and type of electrode and will be found to increase slightly with the thickness of material being welded; if too great for the size of electrode used, the fusion will not be uniform and steady, the electrode itself tending to "spatter," while if the amperage is too small, a proper fusion temperature will not be reached.

The voltage increases with the length of arc, and, in order to prevent this length becoming greater than is desirable for efficient welding, a number of machines and controls have been designed which automatically break the current if the arc is drawn out beyond the desired length. The range of length of arc usually adopted is from ⅛ to 3/16 inch, and the voltage varies from 15 to 25 with bare electrodes and from 30 to 40 with some types of covered electrodes.

The skill of the operator or human element is still the most vital factor. The density of current, and therefore the heat density of the arc, decreases as the length of the arc increases; a short arc, in general, results in a high temperature and virtual vaporization of the metal, while a long arc is apt to lead to the deposition of large drops or "beads" of electrode accompanied by oxidation. Consequently a varying length of arc naturally results in a lack of uniformity of the character of material in the weld. As, however, scientific investigation determines the effect of each of the above-mentioned variables, it will be possible to predetermine and specify with more exactness the ideal conditions under which a successful weld is assured, assuming that the arc is held at constant length. Until such time, we must remain largely dependent upon the skill of the operator, not only in maintaining the constant length of arc, but also in determining a most desirable current adjustment for the work in hand.

It may be interesting at this point to mention that automatic, self-feeding welding machines have already been designed and are now being experimented with. These machines will not only eliminate the factor of varying length of arc but will result in a considerable increase in speed of operation.

The preparation and building up of the joint have considerable bearing not only on the ultimate strength of the weld itself but on the time and cost of making it. Correct preparation of the joint for welding is just as important

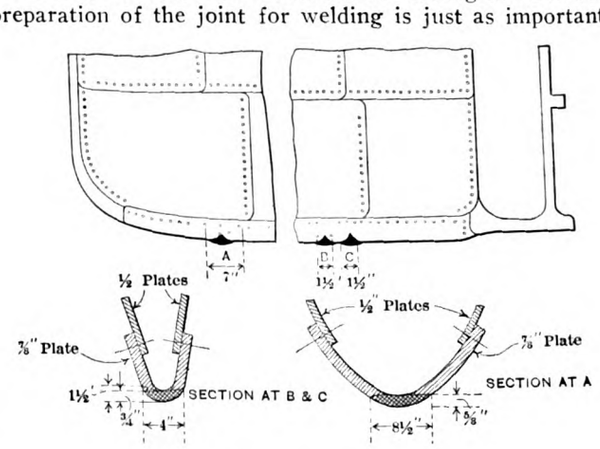

Fig. 4.—Repairs to Furnace Plates

if not more so, as in the case of a riveted joint. The time and cost of welding depends largely on the amount of electrode material deposited, and therefore the joint should be prepared so as to require the minimum amount of building up consistent with the necessary strength and accessibility. In large plates where a long joint, such as a seam, has to be welded, the contraction set up in cooling tends to draw the joint together, and unless proper pre-

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cautions are taken the plates will tend to fold over one another at the end distant from that being welded.

Two methods to counteract this are generally adopted. In the "non-rigid" method the two plates, instead of being placed parallel with the joint, are diverged to the extent of about ⅛ inch to the lineal foot of weld; as the welding proceeds from one end, the plates gradually close together without setting up any great initial internal stresses. This method obviously introduces a number of practical difficulties if applied to the main construction of a vessel. In the "rigid" method the joint is tack welded at intervals along its length and the welding done, not continuously from end to end, but in separate stages, so as to distribute the heat as much as possible uniformly along the joint.

Welding Apparatus

The types of apparatus manufactured for electric arc welding may be divided into three main classes: (1) *Motor generator sets* operating from alternating current or direct current mains and designed to generate a suitable voltage. These machines are generally supplied with controls which automatically adjust the current to the length of arc operating. (2) *Stationary transformer sets* operating alternating current only. (3) *Resistance control.* This is the simplest of the three types and consists generally of a simple cast iron resistance grid which reduces the voltage from the main to that required at the arc, the difference being wasted. Where the main supply is over 110 volts, however, it is necessary to employ a motor generator set or rotary converter, or in the case of alternating current a static transformer, as the waste would be prohibitive.

It will be seen, therefore, that there is a great divergence in type, portability and, needless to say, in cost of apparatus advocated by the various manufacturers of arc welding outfits; and, since they all claim to make a satisfactory weld, it would appear that the question of selection devolves into one of economy of first cost, power efficiency, and portability. In this connection it is important to bear in mind that, while the simple resistance method is the least efficient electrically, its overall efficiency is increased, due to the current saving when the arc is broken, and in practice this probably represents about 50 percent of the total time.

The cost of wiring the shipway or shop is approximately the same with all systems. The average apparatus will work at about 6 to 8 killowatts per welder when welding, but if low voltage is provided at the mains, there are certain outfits which are said to reduce the consumption to as low as 3½ kilowatts, or even less.

Speed and Cost

Unfortunately, there are as yet very little reliable data of a general nature in regard to the speed and cost of welding on straight line work in the field. Again, there are so many varying factors which enter into the question, that any figures can only be considered with due regard to the particular conditions under which they were obtained. The following figures have been computed from some data obtained in England by Capt. James Caldwell, R. E., on work done in the field during the construction of an all-welded barge recently built at Richborough. The figures have been adjusted to suit the present cost of welding labor and electrode material in this country, which differ considerably from those obtaining in England.

Metal Electrode Arc Welding (Quasi Arc)

Plate Thickness	Power used per foot run, amps. at 100 V.	K.W.H. at 3c	Electrode per foot run in cents	Labor a 65c per hour	Time per foot of weld	Speed in feet per hour	Total cost per foot of weld in cents
1/8"	55 amps.	.54c	7.	2.165c	2m.	30	9.7
1/4"	100 amps.	1.35c	12.9	2.954c	2m.45s.	22	12.2
3/8"	100 amps.	4.8c	19.2	8.66c	8m.	7.5	32.66
1/2"	120 amps.	7.2c	25.5	13.00c	12m.	5.	45.7

Other figures prepared by the Electric Welding Committee show the possible cost of a fillet weld on a ½-inch plate, using a motor generator set and bare electrodes, to be as follows:

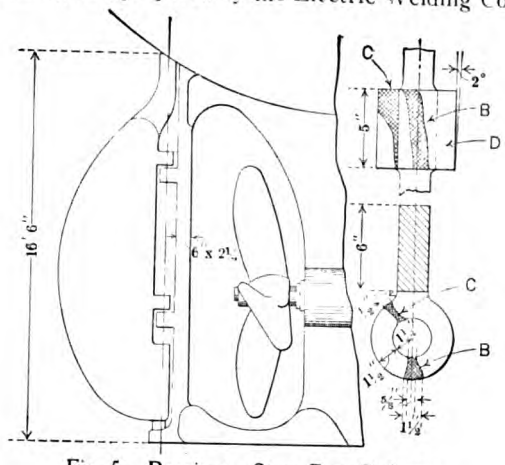

Fig. 5.—Repairs to Stern Post Gudgeon

Average speed of welding on continuous straightaway work	5 feet per hour
Amount of metal deposited per running foot.	.6 pound
Current 150 amperes at 20 volts = 3 kilowatts.	
Motor generator eff. 50 percent = 6 KW ÷ 5 equals	1.2 K.W.H. per 1-foot run
1.2 K.W.H. at 3 cents per K.W.H. equals	3.6 cents per foot
Cost of electrode 10 cents per pound, and allowing for waste ends, etc., equals	7.2 cents per foot
Labor at 65 cents per hour equals.	13.00 per foot
	23.8 per foot

We have seen that skilled workmanship is essential to good welding, and in the absence of any definite means of testing finished work in the field, conscientious workmanship is equally important. A skilled and properly trained welder knows instantly whether or not he is making a good weld. He can tell this by the smoothness of the flow of metal, the uniformity of the sound and light of the arc, and by the lack of "spattering" or deposition of "beads."

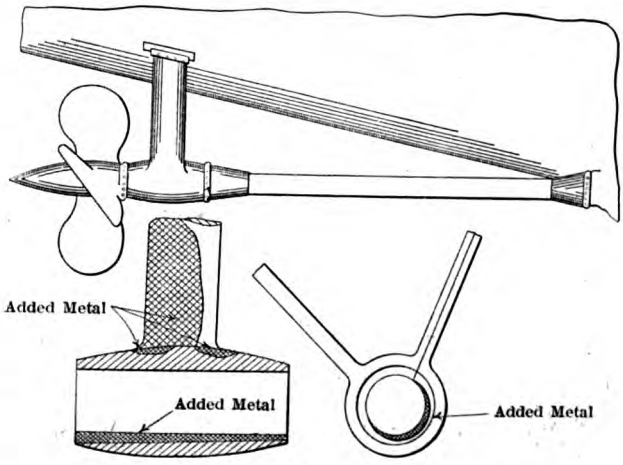

Fig. 6.—Reinforcement of Eroded Propeller Shaft

The welder should possess some knowledge of the ele-

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ments of electricity, how it is generated, conducted and controlled, the melting point of the metals employed, and the properties of the particular electrode in use. In ship work he should understand the correct methods of preparing the various joints and their relative importance, together with the best methods of building them up.

Inspection may be considered under three headings:

(1) Inspection and testing of the electrodes being used; (2) inspection of the work before and during welding; (3) inspection of the completed welds.

We have already seen that the chemical composition and quality of the electrodes used have an important bearing on the quality of the weld produced, and care should be taken to see that only electrodes of the correct chemical compositions are used; that the wire is of proper

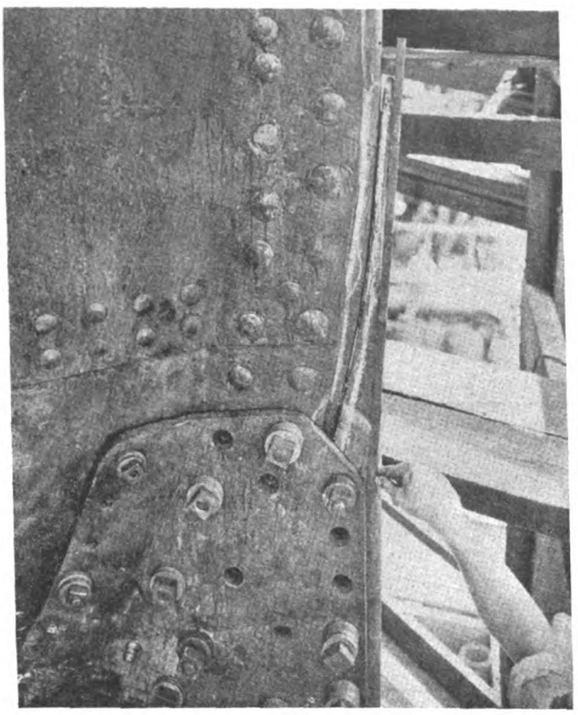

Fig. 7.—Attachment of Otter Extension to Stern

size and of uniform homogeneous structure, free from segregation, oxides, pipes, seams, etc.; that the surface is clean, and that the wire flows smoothly and evenly through the arc without any detrimental phenomena.

All work should be examined and approved before welding commences in order to see that the joints are properly prepared for the particular kind of weld to be made, that the edges are properly fitted or spaced and the work properly closed up.

In the thicker plates the first run of metal or "foundation" weld should be made with a small wire, carefully examined for flaws or defects and passed upon before the next layer of metal is added. This inspection should be carried out by specially trained supervisors, who should also watch the welding in operation, check up the current at the meters, and see that bad welds are cut out.

Various methods have been suggested for the inspection of completed welds, and the Research Committee of the Welding Committee is at present investigating a number of these, including electric resistance, magnetic, X-ray, and acoustic methods, but the problem is extremely difficult and has not yet shown indication of any solution.

In practice, the usual tests applied are by blows from a hammer or by chipping at intervals with a cold chisel or pneumatic tool. Either of these methods will usually detect a really poor weld approaching zero efficiency, but they cannot be relied upon to indicate the value of a joint, which, while not absolutely bad, does not reach the standard of efficiency required in a particular case. For this reason it is most necessary to rigidly test every material and system of welding proposed before accepting them as suitable for application to important strength members.

Present Application of Electric Arc Welding in Ship Repair Work and New Construction

The range of application of the arc welding process to the execution of marine repairs, such as the reclamation of broken castings, fractured plates, boiler furnaces and the reinforcement of eroded or badly wasted plate edges, and cracked hull plates is extremely varied. A few examples of non-structural work for which it is suggested that electric welding is specially adapted are the following:

Deck rail stanchions to plating; attachment of clips and hangers for pipes and wiring to casings, bulkheads, etc.; clips for attaching interior wood fittings to steel work; engine and boiler room stairs and gratings with their attachments; masts, derricks, ventilator cowls and trunking; cargo batten cleats to frames; hatch cleats to coamings; small tanks, bins and racks; skylights, generally; manufacture and attachment of storeroom, galley, and cabin fittings; welding studs in case armor plating for fitting of attachments.

Anglesmith work can be considerably reduced if the flanges of the angle bars are notched out, bent to the proper angle and electrically welded at the junction. The bending can generally be accomplished cold. Watertight or oiltight collars and the bosom pieces of watertight and oiltight boundary bars and bulkheads and double bottom floors can also be largely eliminated.

The saving in labor by welding some of the parts in the above list will average more than 60 percent.

Lloyd's Experiments on Electrically Welded Joints

A series of experimental tests was devised and carried out under the direction of Lloyd's technical staff in England, extending over a period of many months. The investigations were undertaken to determine the possibilities of the application of electric arc welding to shipbuilding, and, as it was desired to obtain as good a knowledge as possible of the physical properties of the combination of rolled and welded material, highly skilled operators were employed. The quasi arc process of electric arc welding was used throughout the experiments.

The general scope of the experiments included:

(a) Determination of modulus of elasticity and approximate elastic limit.

(b) Determination of ultimate strength and ultimate elongation.

(c) Application of alternating stresses with (1) rotating specimens, (2) stationary test pieces.

(d) Minor tests, such as (1) cold bending of welds, (2) impact tests of welded specimens.

(e) Chemical and microscopic analysis.

Tests were carried out on specimens as large as possible, particularly in respect to the static determinations of elasticity, ultimate strength and elongation, some of the test specimens being designed for a total load of just under 300 tons. The advantage of these large specimens was that the effect of workmanship was better averaged and the results were more comparable to the actual work likely to be met with in ship construction.

(*To be continued.*)

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Standardization of Ship Steel

Less Diversity in Thickness Recommended—American List Provides Larger Number of Shapes with Fewer Thicknesses

TWO conferences of vital importance to shipbuilders and steel makers were held in Philadelphia on November 19 and 20, 1918. The first was a conference of steel makers to take action on modifications in rolls to produce ship channels and shipbuilding bulb angles, and the second was a conference between the steel makers and representatives of the Emergency Fleet Corporation to take action on a revision of the American standard practice and to recommend a selected list of structural shapes most suitable for ship construction.

Representatives were present at these conferences from all the larger mills which manufacture structural steel shapes—the Bethlehem Steel Company, Cambria Steel Company, Carnegie Steel Company, Eastern Steel Company, Illinois Steel Company, Inland Steel Company, Jones & Laughlin Steel Company, Lackawanna Steel Company, Phœnix Iron Company, Tennessee Coal, Iron & Railroad Company—and at the second conference the United States Shipping Board Emergency Fleet Corporation was represented by Fred T. Llewellyn, in charge of steel standardization, engineering section, division of steel ship construction, and by A. J. C. Robertson, chief designer.

Standardization of Ship Steel Begun Over a Year Ago

The first step in the direction of the standardization of ship steel was taken on July 2, 1917, when representatives of the above-mentioned companies, together with representatives of the manufacturers of plates, met in Washington and adopted the standard practice recommended by American steel makers, and subsequently adopted by the Emergency Fleet Corporation as a guide to the shipyards in placing orders with the mills for ship steel. The effect of the standard practice has been to eliminate minute variations in the thicknesses of plates ordered from the mills and to simplify the transmission of orders from the yards to the mills; and the situation as regards plates has been so greatly improved as compared with pre-existing practice that the plate mills have been able to make some remarkable production records.

At the time the standard practice was adopted it was deemed inadvisable to prepare a selected list of structural sections, but only to recommend that in general the use of sections rolled infrequently be eliminated and that orders be confined as far as possible to American standard beam sections, American standard structural channels and plain angles, provided, however, that ship channels and bulb angles might be rolled if required on shipbuilders' schedules. While it was recognized that the bulb angle and the ship channel were more suitable than any other sections for ship construction, the limitation in the use of ship channels and bulb angles was due to the lack of adequate facilities for their manufacture, and it was the desire of the steel makers to make as broad as possible the allocation of ship steel to all makers.

It was further considered unnecessary to draft a selected list of structural sections for the reason that it was believed the Emergency Fleet Corporation's plan for the standardization of the designs of hulls, particularly cargo vessels, would of itself operate to reduce the number of structural shapes required, and therefore no further action would be necessary. The recommended list, however, did limit the number of plain angles.

The experience of sixteen months has made it clear to American steel makers that the structural channel, by reason of its narrow flanges and steep inner flange slope, is not an entirely satisfactory section for use in hull construction; further, that the bulb angle is in very many respects a most desirable section for ship construction and that its use should be encouraged rather than discouraged, and, further, that the introduction of beams and structural channels into the list for ship steel had opened the way to the use of an enormous number of structural sections with relatively limited tonnages per section.

This situation had also come to the attention of the Emergency Fleet Corporation by reason of the difficulties which, due to the use of a great variety of sections, the shipyards had had in securing an adequate supply of all these sections in due sequence as required in construction. In consequence, an investigation was inaugurated in the Division of Steel Ship Construction, Daniel H. Cox, manager, with a view to the tabulation by tonnages, shapes and thicknesses of all the sections used at the yards, so as to make possible the compilation of a selected list of sections for use in the construction of ships on the basis of which it might be possible to insure the receipt of steel in adequate volume and due sequence, and also to arrange for warehouse stocks of suitable sizes at conveniently located points.

Diversity of Sections Used

This investigation, which was carried on by Mr. Llewellyn, covered 1,508 hulls of 10,302,150 deadweight tonnage either requisitioned or under construction by the Emergency Fleet Corporation, with a total shape weight of 1,100,651 net tons distributed among 131 different structural shapes in 403 thicknesses (sections). It was noted that in the case of one design for a 5,000-ton boat with but 1,026,966 pounds of structural shapes, there were 42 different shapes and 118 separate thicknesses (sections), of which nine sections were rolled only at one mill and one tee section only at another mill. Of separate sections there were items as low as 8 pounds each, and 35 sections less than 500 pounds each. Of one shape, only 43 pounds were required.

If such tonnage were the only tonnage available at the mills for this particular shape, it would require material for 4,600 boats to accumulate before considerations of economical production would justify placement of rolls. Of another relatively heavy shape on the same basis, economical production would require tonnage for 1,000 boats to accumulate. In the case of another cargo vessel of 9,400 tons, requiring 1,800,103 pounds of structural sections, there were only 16 separate shapes and but 44 thicknesses, and of each separate shape the minimum quantity of any one thickness was 2,800 pounds, and that of a section in very general use. The next smaller item on that list was three tons of a small angle section, which would only require material for 66 boats to accumulate. By the addition of 55 tons to the weight of the steel, the number of shapes in that particular boat might be reduced to 8 and the number of different sections to 19.

This investigation also indicated that, while a number of steel makers rolled bulb angles and ship channels, those sections represented the growth of years and reflected the individual ideas of the shipyards for which rolls were first

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turned. There had been no definite endeavor to standardize these sections, with the consequence that American steel makers published different dimensions, weights and properties for sections of the same depth, the use of which at the yards should be interchangeable.

Conformation to British Standards Recommended

With the completion of his report and its distribution to the shipyards and to the steel makers, Mr. Llewellyn recommended that ship channels and shipbuilding bulb angle sections be adjusted to British standards, that steel makers confer and agree to publish like ranges of weights and dimensions, and that there be prepared for distribution to the yards a selected list of sections recommended as most suitable for ship construction.

The conferences were held in the offices of the Cambria Steel Company, with George E. Dix, assistant to the general manager of sales, in the chair. R. B. Woodworth, engineer with the Carnegie Steel Company, who had been instrumental in the formulation of the original standard practice, presented detailed written proposals as a basis of discussion for the modification and standardization of ship channels and bulb angles and for the revision of the American standard practice.

It was decided by the steel makers that inasmuch as the British standard sections of ship channels and shipbuilding bulb angles appeared to be better adapted to economical manufacture than the American standards, and inasmuch as the new rolls which had been turned in recent years to produce those sections conformed in general to British standards, hereafter American standards should be discontinued and rolls in hand not to British standards should be redressed at as early a date as possible to roll such sections as closely to British standards as slightly divergent methods of production would allow, particularly in view of the further fact that the adoption of British standard sections would enable American mills to compete on an even basis for ship steel wherever utilized in shipyards, either at home or overseas.

Three Bulb Angle Thicknesses Recommended

It was further agreed that in general ship channel rolls would be dressed so as to produce the Lloyd minimum and maximum thicknesses with one thickness .05 inch less than British standards, and that mills publish but one intermediate thickness in the Lloyd range of ship channels, and that in bulb angles in general where the Lloyd range seems to be too arbitrary and to provide an unnecessary number of thicknesses, the Lloyd range should be aimed at only in the deeper sections, that there should be but one thickness below British standards and that intermediate thicknesses be published to vary by .05 inches, bulb angles to show exact leg dimensions at British standards and at .10-inch intervals above.

Modifications in Standard Practice

Careful consideration was then given to a selected list of structural shapes to be recommended for ship construction, together with those modifications in the standard practice which the experience of sixteen months indicated to be desirable. These were further discussed at the second conference with representatives of the Emergency Fleet Corporation, and it was further recommended to the Emergency Fleet Corporation that as soon as possible a technical order be issued to all shipyards to put these recommendations into effect and that, so far as possible, orders for structural sections to be used in ship construction be governed by the recommended list of sections, as shown in the table.

STRUCTURAL SHAPES RECOMMENDED FOR SHIPS

Dimensions in Inches

Bulb Angle Weights Approximate

Equal Leg Angles

Size Inches	Thickness, Inch	Weight per Foot, Pounds	Size, Inches	Thickness, Inch	Weight per Foot, Pounds
6 by 6	.750	28.7	3½ by 3½	.625	13.6
	.6875	26.5		.5625	12.4
	.625	24.2		.500	11.1
	.5625	21.9		.4375	9.8
	.500	19.6		.375	8.5
	.4375	17.2		.3125	7.2
	.375	14.9		.250	5.8
5 by 5	.750	23.6	3 by 3	.500	9.4
	.6875	21.8		.4375	8.3
	.625	20.0		.375	7.2
	.5625	18.1		.3125	6.1
	.500	16.2		.250	4.9
	.4375	14.3			
	.375	12.3	2½ by 2½	.375	5.9
				.3125	5.0
4 by 4	.750	18.5		.250	4.1
	.6875	17.1			
	.625	15.7	2 by 2	.250	3.19
	.5625	14.3		.1875	2.44
	.500	12.8			
	.4375	11.3			
	.375	9.8			

Unequal Leg Angles

Size, Inches	Thickness, Inch	Weight per Foot, Pounds	Size, Inches	Thickness, Inch	Weight per Foot, Pounds
6 by 3½	.750	22.4	4 by 3	.500	11.1
	.6875	20.6		.4375	9.8
	.625	18.9		.375	8.5
	.5625	17.1		.3125	7.2
	.500	15.3			
	.4375	13.5	3½ by 3	.500	10.2
	.375	11.7		.4375	9.1
				.375	7.9
5 by 3	.500	12.8		.3125	6.6
	.4375	11.3		.250	5.4
	.375	9.8			
	.3125	8.2	3 by 2½	.375	6.6
				.3125	5.6
				250	4.5

Bulb Angles

Size, Inches	Thickness of Longer Leg, Inch	Weight per Foot, Pounds	Size, Inches	Thickness of Longer Leg, Inch	Weight per Foot, Pounds
10 by 3½	.725	35.2	8 by 3½	.550	23.2
	.675	33.2		.500	21.6
	.625	31.1		.450	19.6
	.575	29.1		.400	18.6
	.525	26.9			
	.475	24.9	7 by 3½	.525	20.0
				.475	18.6
9 by 3½	.625	28.6		.425	16.8
	.575	26.6		.375	15.3
	.525	24.8			
	.475	22.7	6 by 3	.475	15.6
	.425	20.9		.425	14.1
				.376	12.8
				.350	12.2

Ship Channels

Size, Inches	Thickness, Inch	Weight per Foot, Pounds	Size, Inches	Thickness, Inch	Weight per Foot, Pounds
12 by 3½	.700	40.8	8 by 3½	.525	25.3
	.600	36.8		.425	22.6
	.500	32.7		.375	21.2
	.450	30.6			
			7 by 3½	.500	22.5
10 by 3½	.675	34.8		.400	20.1
	.575	31.4		.350	18.9
	.475	28.0			
	.425	26.3	6 by 3½	.475	19.8
	.375	24.6		.375	17.8
				.325	16.8
9 by 3½	.650	31.3			
	.550	28.3	6 by 3½	.350	15.2
	.450	25.2			
	.400	23.7			

Tees			Hatch Zee (Tyzack)		
6½ by 6½	.450	19.8	2½	.500	13.6

15-Inch Structural Channels

Thickness, Inch	Weight per Foot, Pounds	Thickness, Inch	Weight per Foot, Pounds
.818	55	.524	40
.720	50	.426	35
.622	45	.400	33

27 Shapes—115 Sections

Sections not shown in the above list may be included on shipbuilders' schedules, with the proviso that they be specified only when they can be ordered in lots of not less than 40,000 lineal feet per shape at one time, or by special arrangement with the mills. Orders for such shapes should not be divided among mills, but the entire

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quantity of each shape should be placed at one mill with the express stipulation that that mill may at its option roll, ship and invoice all the tonnage at one time regardless of its position in the shipyard and fabrication schedules.

THE BRITISH ADMIRALTY STANDARDS

It is to be noted in this connection that the same problem of the standardization of ship steel has had the careful attention of the British Admiralty, the steel makers and the shipyards of England where the multiplicity of sections specified on shipyard schedules has also interfered with the progress of ship construction. In consequence, under the auspices of the Admiralty and the Ministry of Munitions, to facilitate regular and frequent rollings and thus avoid delays, a list of standardized sections has been drawn up and published in a pamphlet entitled, "Procedure for Obtaining Ship Steel, December, 1917." For cargo vessels (standard ships) this list includes but four sizes of angles—6 inches by 6 inches, 6 inches by 3½ inches, 3½ inches by 3½ inches, and 3½ inches by 2½ inches; three sizes of bulb angles—10 inches by 3½ inches, 9 inches by 3½ inches, and 8 inches by 3 inches, and but two sizes of ship channels, a 12-inch by 3½-inch light section and a 12-inch by 3½-inch heavy section. For Admiralty oilers (tankers) there are shown but four sizes of angles and six sizes of bulb angles.

While the number of shapes in the English list is much smaller than the number of shapes in the recommended American standard practice, English mills are accustomed to roll shapes with much narrower variations in thickness than American mills, and in view of the desirability of the widest possible growth of ship construction in the United States it is inadvisable too narrowly to restrict American shipyards. The American list provides a larger number of shapes with fewer thicknesses.

Reconstruction and Extension of American Merchant Marine*

THE creation of free ports, the construction of adequate warehousing facilities, and the adequate provisioning of our harbors with docks and machinery for the speedy loading and discharging of cargoes constitute possibly the most important factors which will secure for our country its rightful place in the world's international trade. Our wealth, our resources, our sound business reputation and our geographical position designate us to accomplish our great role in the coming work of reconstruction.

European countries will need grain, cotton, wool and raw material of all sorts. We will have to supply them not only with all our normal surplus, but also with the war products of Eastern Asia and South America. The colonial markets situated on our west and south will need millions of manufactured commodities of which they have been deprived during all these years of war, and capital to increase their productivity. We must try to supply them not only with our own products, but with those of our allies, whose energies should not be diverted by problems of shipping, but left free to concentrate on the production of goods, the export of which is necessary for the rehabilitation of their finances sorely in need of recuperation. For the same reason we will have to supply colonial markets with the capital they need to develop their natural resources.

Similar reasons have in the past made of Lubeck, Hamburg, Amsterdam, Antwerp, London and Liverpool the transshipment harbors and entrepôts of the world trade. As the axis of international trade has always traveled from east to west, it is permitted to presume that, with the development of the last years, it will soon touch our shores; but as in the past it has been proved that an enterprising nation, seeing a little ahead of time, can make the course of international trade deviate to its shores provided they are situated in the proper general direction, it will be up to us to attract and retain for many generations the international flow of commercial transactions between our terminals of the Atlantic and the Pacific. To do this we merely need to follow the example set forth by the enterprising Hanseatics, Dutch, Flemings and Englishmen.

The necessity of erecting adequate docks and machinery in our harbors is generally understood by all. Its details are, however, to be worked out by experts, and it should be left to the city and port authorities of every harbor to discuss the subject with their engineers. It would suffice that citizens of such ports took up the discussion through the ordinary channels with the competent authorities, so as to impress them with their desire of increasing port facilities in order to attract trade by giving efficient service. The construction of adequate warehousing facilities is a matter which can only be left to private initiative. Financiers and tradesmen of our big harbors should at once get together to discuss ways and means to create new warehouse companies and increase the capacities of the existing ones.

As for the creation of free ports in our key harbors, by this we mean ports situated along the international trade routes passing through the United States, this measure would require complicated negotiations between several interests and federal, state and port authorities. In fact, the aim of a free port is to afford transshipment and warehousing facilities for transient goods. To this effect, a certain part of the port is fenced off and set apart and all goods discharged and warehoused "in bond" in this segregated part are free of custom duties, as they are, in principle, destined to leave the country. In other words, they are receiving for shipping convenience the hospitality of a port before being shipped to their ultimate destination. It goes without saying that, should they have their destination changed and be sent outside the limits of the free port for consumption in the country which has offered them hospitality, they fall at once under the usual custom tariff.

The results obtained by the establishment of free port zones are at once apparent. Harbors which have had recourse to this system have become distribution points not only for their hinterlands, but for the international trade of the world. It goes without saying that if a producer in China, for instance, has shipping facilities to send his raw material to an American port on the Pacific where he knows that his goods will be stored free of custom duties until a purchaser offers himself, and that if European buyers in quest of Chinese raw material know that they can find it in an American Pacific port where they will have no other expenses than those of transshipment, which, through special arrangements with railroad lines and other shipping companies, can be held at a comparatively low scale, both the Chinese producers and the European merchants will transact their operations in the American port.

With good shipping facilities, warehouse accommodations and free zones, American harbors on both oceans would become the distribution points of the world's commerce and would secure for the United States not only all the advantage lawfully falling to the middleman, but also all those deriving from freight charges.

* From talk with Secretarial Department, Equitable Trust Company, of New York.

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Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

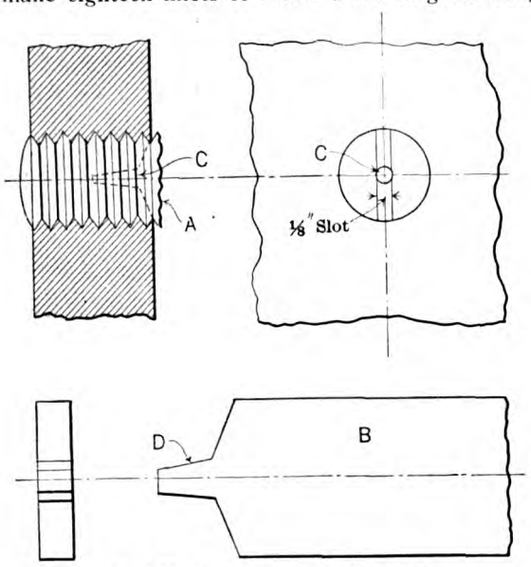
This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Device for Removing Broken Studs

During the last eighteen months or two years I worked in the engine room of a certain ship running on a certain ocean between certain ports. That seems to be about the current style of telling where you are and what you are doing.

During these voyages the ship has had to look out for and dodge "tin fish," as we call them. As this is accompanied with considerable danger, there has been trouble in getting crews, engine room and fire room forces.

Right here, Mr. Editor, I would like to say that, given a skipper as good as the one I sailed under, a ship that can make eighteen knots or more is not in great danger



Tool Fitted to Remove Broken Studs

from "tin fish." If the United States Government puts afloat twelve-knot boats she is simply feeding these "tin fish" and will be making a grave error. But "that's another story," as Mr. Kipling says.

A nice-looking young fellow came down into the engine room while we were lying at a certain port. He said that he would like to go to sea—was a machinist and had built and run small engines. After a little talk we took him up to the shipping office and he was given an oiler's berth.

He wasn't seasick in the slightest. In two or three days he seemed perfectly at home and contented. We had on board a dense air ice machine. As the young man had never seen one of these he wanted to know why it wasn't working. The fact was that the lock nut on the compressor piston rod had become loose. It seems that the cotter pin had been carelessly left out when a set of new leathers had been put on the piston. Consequently, the back cylinder head was knocked off, carrying with it three studs, which broke off close to the cylinder castings. We had no time to replace these broken studs nor, in fact, did we have anyone able to tackle the job.

"I'll take them out," the young fellow said, "if you will give me a stud wrench." I asked him how he was going to get a wrench on a stud which was broken off flush with a casting. I had no such wrench. He seemed puzzled at first, but finally said, "I'll go 'upstairs' into the machine shop and make one, if you will let me. I can get out the studs in no time." In about an hour he came down with the improvised tool shown in the illustration. The material was a piece of ¾-inch round tool steel, *B*, 12 inches long; one end was squared for a wrench, the other was machined as shown, hardened and drawn to a deep straw color.

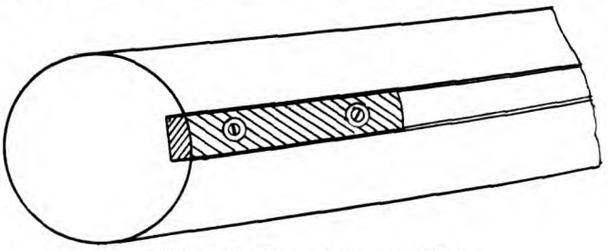
The young man drilled an eighth of an inch hole, *C*, in the center of each broken stud, *A*, with the electric breast drill. Then with a small cape chisel, which he got from the tool chest, he chipped from the outside edge of the stud two slots opposite each other, starting from the face of the casting and running at an angle down into the eighth-inch drilled hole. These slots were about ⅛-inch wide. The angle was about the same as the tit, *D*, turned on the end of the piece of tool steel. Putting the tool back into the stud, and the wrench on the squared end, the young man backed the broken stud out with as much ease as a whole one could be put in.

Now, Mr. Editor, the whole trick in this—and it is a good one—lies in the taper, as it is evident that it gives a great length of bearing which cannot be obtained by chipping a straight slot for an ordinary screw driver. It is, of course, evident that the little round tit on the end of the wrench or screw driver is not necessary. A piece of flat steel tapered off would act just as well—in fact, I know it would, as I have tried it.

ENGINEER.

Adapting Keyed Shafts for Loose Pulley

It frequently happens that shafting intended for a tight and loose pulley drive is keyseated its entire length. As a result, the loose pulley usually wears out and becomes wobbly in a short time because of the cutting effect of the



"Filler-in" Piece on Loose Pulley

sharp edges on the keyway. The best course is to order the shaft with the keyway where the loose pulley is to run. If, however, the keyway is encountered it can be readily fixed up by inserting a filler-in piece as shown in the accompanying sketch; the way is filled up with a piece of steel, fixed in place with countersunk screws and then emeried off until an even bearing surface is obtained. The time and trouble necessary to put in this filler is well compensated for by the increased life of the loose pulley and reduced friction loss.

Philadelphia, Pa. W. A. LAILER.

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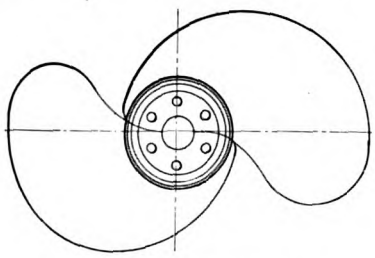
The Propeller

A great deal has recently been said and written concerning ship design, ship construction and the various parts of machinery in use in modern steamship installation. Seldom, however, is the propeller even mentioned, much less discussed, or improvements in its design suggested. Since John Ericsson made the propeller and put it into common use, the impression has been that it cannot be improved. Perhaps that is so. I have often wondered, however, why a serviceable propeller could not be constructed by using two loose blades, fitted into a hub made in two parts, and bolted together. If the blades were then made larger at the rear end, the propeller in action, would exert more force, since it would be pushing against the water steadily, instead of cutting it as does the three- or four-blade propeller. The illustrations show the details of such a design. I should appreciate the criticism of those interested in this idea.

Proposed New Type of Propeller



Shape of Two-Blade Propeller

Worcester, Mass. E. M. PETERSON.

Place for Utilizing All Vessels and Training Crews

I have read with interest the article "Manning the New Merchant Marine." In addition to the details outlined, I would further suggest a signal plan for the training of officers and crews.

First, that the prospective marine officer send his application to the Sea Service Bureau with details as to his qualifications, former experience, actual service, if any, and branch of service in which he desires to enlist.

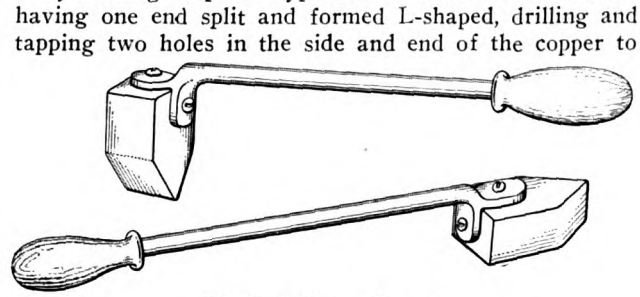
Second, on the basis of this information, if it be known that the applicant has seen actual sea service, but not as an officer, he should be enrolled in a special class, training him in the science of navigation or marine engineering until he passes a rigid examination as an officer. After this, he should be sent aboard ship, but not yet as an officer, to receive further instructions at the hands of competent commanding sea captains, or Government instructors provided especially for this training purpose. At the conclusion of this training a second examination should follow, when final license is granted the new officer.

In training crews for the merchant marine, I would suggest that the Shipping Board secure competent instructors and place them on board of ships, which are specially suited for training new men, in actual service of ocean commerce. Each of these ships should be provided with an instructor and a crew of from ten to fifteen men, these men to work in conjunction with the trained crew during specified watches, and separately under the supervision of an instructor until such a time as they can be readily inducted into the trained crew's service. Arrangements must be made so that one ship and instructor trains men for deck hands, and another for fireroom, engine room, or steward's branch, etc.

Stillwater, Minn. OTTO DORTHEN.

Handy Soldering Copper

By making a special type handle from round iron rod having one end split and formed L-shaped, drilling and tapping two holes in the side and end of the copper to match the holes in the handle feet, as shown in the sketches, the soldering copper is made more useful, as it can then be handily used on all sorts of work.

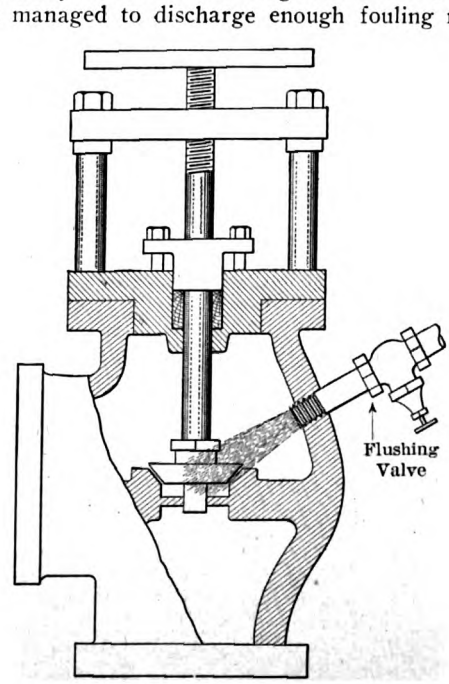


Handy Soldering Copper

C. H. W.

Flushing Valve Seat

The sketch shows how we cured the disagreeable trouble of a valve seat that always leaked, due to fouling. The valve was an outboard delivery valve of a bilge pump and auxiliary condenser discharge line. The bilge pump always managed to discharge enough fouling matter to prevent the proper seating of the valve, and when repairs were to be made on the pump line sea water almost always leaked.



Flushing Valve Seat

By putting in a 3/8-inch valve connection, as shown, and connecting it to a water pressure, this was used to flush the large valve seat each time the valve was closed. This eliminated the trouble. "OLD TIMER."

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Cleaning Handhole Plates on Babcock & Wilcox Boilers

This subject is one that few engineers would perhaps think of writing about, yet it is one that is worthy of being given a share of attention. As the writer has had to handle a battery of sixteen Babcock & Wilcox boilers that called for cleaning of all tubes every month, he has tried in his own way to cut down the enormous amount of

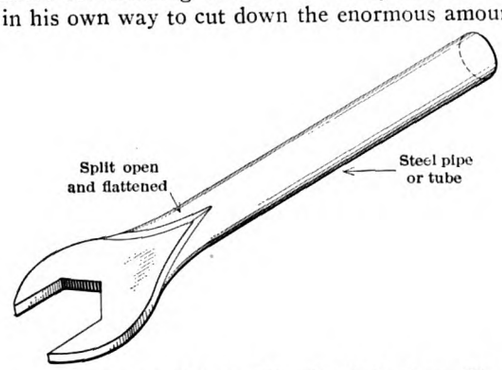

Fig. 1.—Light Skeleton Wrench Made from Pipe

labor required, and in these notes and sketches he passes on a few homely ideas for others to improve upon.

In the work of cleaning thoroughly the tubes of one boiler of the 27-header type, there is involved the removal and cleaning of 581 handhole plates. Multiply this by the total number of boilers (16) in the plant, and we find there are 9,296 plates. Now there is a seat on the plate and one in each header, making two joint seats for each to clean. It can readily be seen that any devices or schemes that will aid in shortening the time needed to clean one plate will save much time and labor when multi-

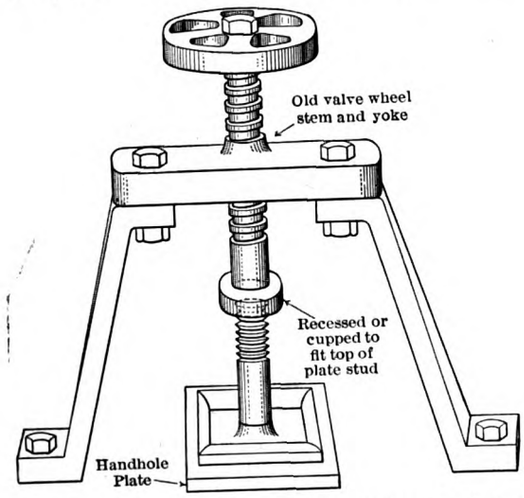

Fig. 2.—Rig to Hold Babcock & Wilcox Boiler Handhole Plates While Cleaning Gasket Seat

plied into the whole operation, and that it will pay to adopt them.

When the writer first took charge of the work of cleaning the boilers, the method in use was that of using the bench vise to hold the plate while running over the stud with a die stock to clean the threads of the stud. As there was but one vise available to each fireroom, it permitted but one man to do this work at a time. The cleaning of the gasket seat was done by men sitting astraddle of a plank and holding the plate in a recess in the plank, scraping the seat with a scraper. This was a very poor means and caused serious waste of time. The nuts for the plate studs were also held one at a time in the bench vise and retapped. One can see how slow such methods were. While the writer does not claim to be an efficiency expert nor an inventor of labor-saving devices, he has managed to speed up the work in such a way with the aid of these home-made devices that the whole time of cleaning the plates and seats on one boiler is accomplished with ease in eight hours by six men, where the old method took sixteen hours with eight men.

When starting to take the plates off the dirty boiler, one man takes the regular long lever plate nut wrench and goes ahead loosening up the tight nuts. He is followed by another man with a light skeleton wrench made from pipe, shown in Fig. 1. This man unscrews the nuts right off, throwing them into a coal bucket, and the plate dogs into a pile. Another man follows him, kicking the plates in and taking them out of the header. He puts these into a pile. As the plates, dogs and nuts begin to pile up, men start work cleaning them.

The rig used for holding them down securely to the bench while they are scraped is shown in Fig. 2. It is

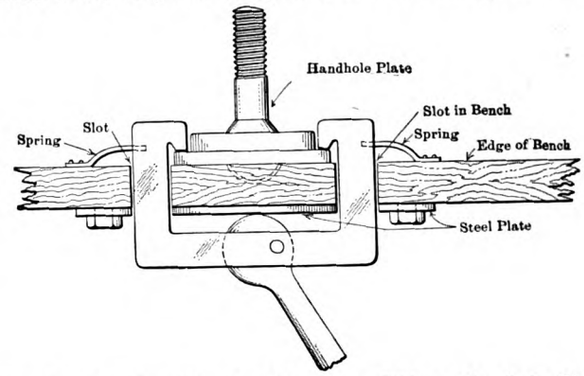

Fig. 3.—Clamping Rig for Babcock & Wilcox Handhole Plates While Running Die Over Studs

made from old valve parts. The screw or old valve stem is recessed on its end to fit easily over the plate stud, and a quick turn of the valve wheel secures the plate, thus holding the plate permitting the worker to use both hands in working the scraper cleaning the old gasket off the seat.

After the seat is cleaned, the plate goes to the next man on the bench, who runs the die over the stud threads. The special plate-holding rig is shown in Fig. 3. This device is quickly and easily operated. It is worked by an eccentric clamp and lever. The rig consists of just two pieces, the U-shaped clamp and the eccentric lever. There are two pieces of flat spring steel used to raise the device when the clamp is released. A metal plate is secured to the under side of the bench to reinforce the edge of the bench where the slots are cut. This plate also acts as a wearing plate for the clamp to work on. A small recess

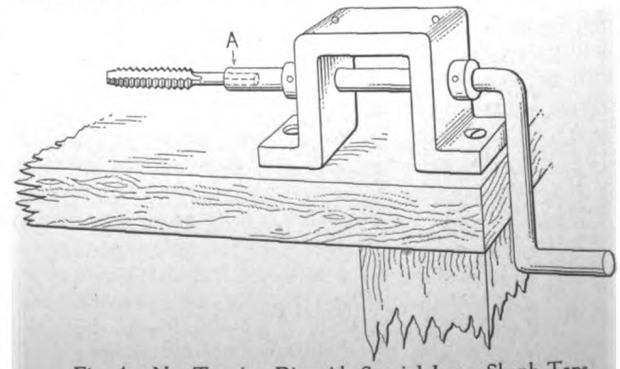

Fig. 4.—Nut Tapping Rig with Special Long Shank Taps

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is cut in the bench for the round head of the handhole plate stud, as indicated by the dotted lines.

The stud nut tapping rig is shown in Fig. 4. This is a

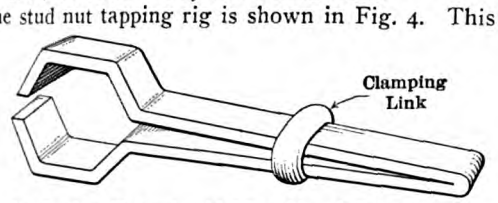


Fig. 5.—Nut Tongs for Holding Nuts While Tapping

very simple affair, easily constructed and one that permits the rapid re-tapping of the nuts. The taps used have special long shanks, permitting four or five nuts to be run

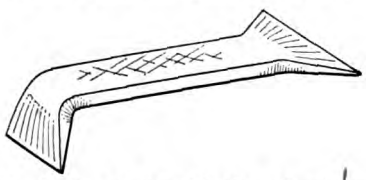


Fig. 6.—Scraper for Cleaning Handholes

on the tap before taking the top off to remove the nuts. The squared section of the tap shank that enters the chuck at *A* is 1½ inches long and is an easy fit. This

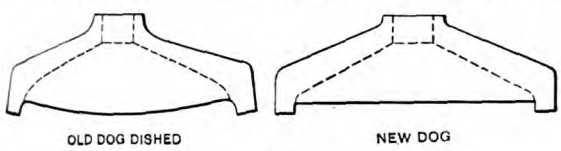


Fig. 7.—Before and After Straightening

length setting in the chuck insures the tap staying in there with nothing else to hold it, and as the nuts are always fed on against the tap nothing tends to pull it out.

Light, easily operated nut tongs for holding the nuts while tapping are made of ⅛- by 1-inch strap iron, as

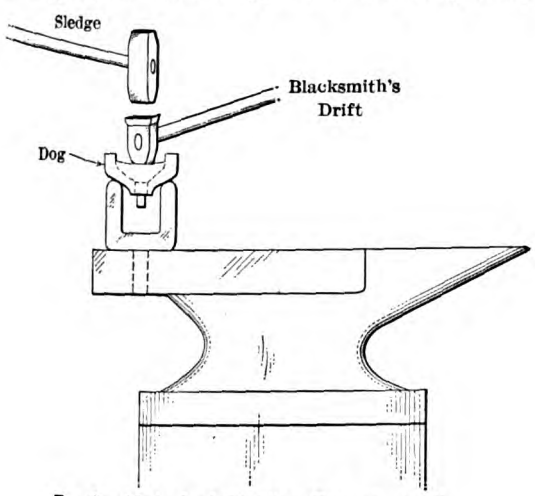


Fig. 8.—Method of Holding Dog on Anvil

shown in Fig. 5. Small scrapers for cleaning the inside seat of the handhole in the headers are made of small, flat files that are worn out and of no further use for filing. These are shaped as shown in Fig. 6. A plentiful supply of these kept sharp are needed.

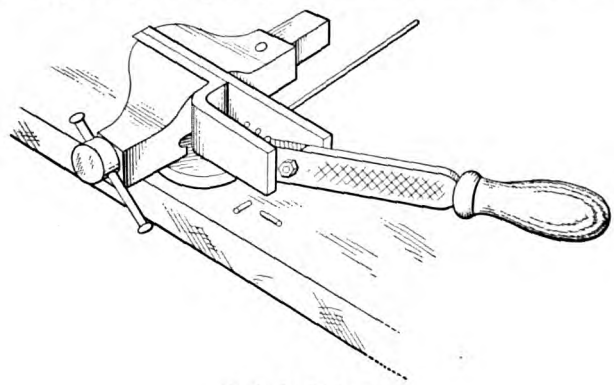
Many of the plate dogs that have been pulled up pretty tight to keep the plate gaskets from leaking become dished so that they touch the plate in the center. When they are found dished like this, they are put in a separate pile and a man is put to work re-shaping them. The dog is heated cherry red and then held over a U-iron on the anvil and driven back with a sledge and a blacksmith's drift, as shown in Fig. 8.

The writer has described these home-made rigs and ideas to show how we have schemed to lighten the work. If any of the readers have better or similar ideas, let's have them. We will all benefit by them.

C. H. WILLEY.

Pin Shear

Where it is necessary to cut a lot of small pins or shear small round stock, such as brass, copper or drill rod, a very handy and efficient shear for the purpose may be very easily and quickly made from a piece of flat stock



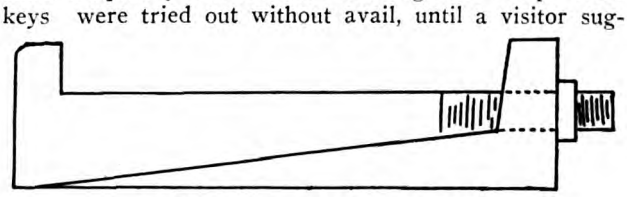
Drill Rod Cutter

and an old flat file. The file should have a hole punched in it about 4 inches from the tip, and one edge sharpened, the side of the file working on the stock being ground smooth. A length gage can be made of similar thin flat stock, and the whole thing held in the bench vise.

HANDY MAN.

Curing a Troublesome Loose Flywheel

On a small air compressor we encountered considerable trouble because the flywheel which was keyed to the shaft frequently worked loose and began to creep. New keys were tried out without avail, until a visitor sug-



Wedged Key to Hold Flywheel

gested that we use a wedge key which he described as shown in the accompanying sketch. This was made up of two parts so arranged that they could be pulled up and wedged by turning a bolt on the one end. We had one of these made up and installed on the wheel. After adjusting it several times and taking up the slack it kept tight and altogether eliminated the trouble previously encountered.

Philadelphia, Pa. W. A. LAILER.

The "coming in" of the electrically welded ship is shown by the significant action of Lloyd's Registrar of Shipping in England. The company has taken a very active stand toward electric welding, has spent large sums of money in experimental work and recently issued provisional regulations under which ships built wholly by electric welding will be separately classified.

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Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding Will Be Answered in this Department

CONDUCTED BY "NAVAL ARCHITECT"

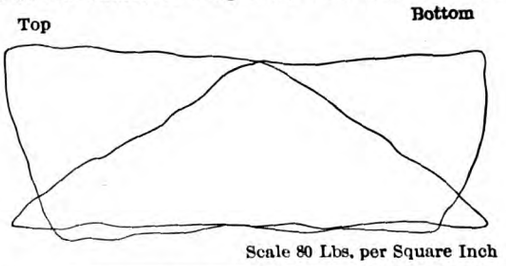
This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

There will appear in this column from time to time questions which have been asked by the Board of Steamboat Inspectors in the various examinations for engineers' licenses conducted by them. Such questions will be denoted by an asterisk (*) placed before the number if from examination for grade of chief, and by a dagger (†) if from examination for other grades.

Horsepower of a Triple-Expansion Engine

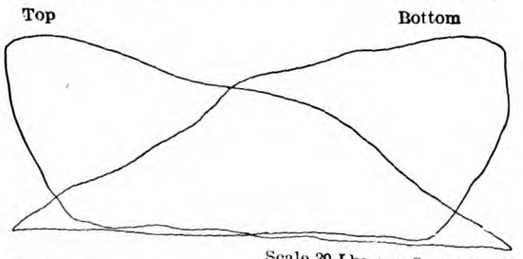
Q. (988).—Using your own data, sketch a set of cards for a triple-expansion engine and work out the horsepower of same. I have in mind an engine that I trust you will take the dimensions of and use them as data for this problem. The cylinders are 14½ inches, 23½ inches and 39 inches in diameter by 28-inch stroke. The boiler pressure is 180 pounds per square inch and the engine turns at 100 revolutions per minute.

A. (988).—To illustrate one efficient method, suppose we proceed as follows: Having given the area and the length of the indicator diagrams, work out in detail the



H. P. CYLINDER

horsepower for one diagram. The total horsepower is simply the sum of the horsepower of both the top and bottom ends for all the cylinders This is best illustrated by making a table, as has been done several times in the columns of this magazine.



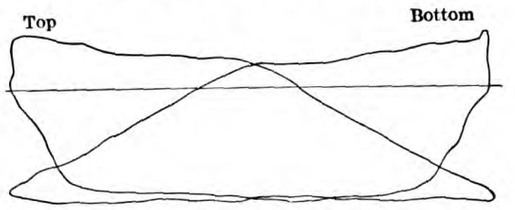
I. P. CYLINDER

Engine, 14½ inches by 23½ by 39 inches, with 28-inch stroke. Boiler pressure, 180 pounds per square inch; 100 revolutions per minute. Take the diameter of piston rod as 4½ inches.

The first step is to find the area in square inches of each card, together with its length in inches. A planimeter will furnish the easiest method of obtaining the area, although it can be found by any of the rules given for that purpose. For our purpose, let us take the bottom end of the high pressure cylinder. Since the area of the diagram is 3.20 square inches and the length is 3.52 inches, the mean height is

$$\frac{3.20}{3.52} = .909 \text{ inch.}$$

As the scale of the diagram is 80 pounds per square inch,



L. P. CYLINDER

the mean effective pressure (M. E. P.) is .909 × 80 = 72.7 pounds per square inch. Our formula for indicated horsepower is

$$\frac{P\ L\ A\ N}{33{,}000}.$$

P = mean effective pressure in pounds per square inch.
L = stroke of engine in feet.
A = area of piston in square inches.
N = number of working strokes per minute.

In this case the area of the piston will be that circle of 14½ inches diameter minus the area of a 4½-inch circle (thus allowing for the piston rod), or 165.1 — 12.6 = 152.5 square inches.

Hence we have for the bottom end of the high pressure cylinder,

$$\text{Indicated horsepower} = \frac{72.7 \times 2.33 \times 152.5 \times 100}{33{,}000} = 78.3.$$

Below we have tabulated the horsepower of the whole engine:

	H. P.		I. P.		L. P.	
Cylinder	H. P.		I. P.		L. P.	
Diameter cylinder	14.5		23.5		39	
Area cylinder, square inches	165.1		434		1,195	
Area, piston rod	12.6		12.6		12.6	
	Top	Bottom	Top	Bottom	Top	Bottom
Area, piston	165.1	152.5	434	421	1,195	1,182
Area, card, square inches	3.45	3.20	3.25	3.39	2.38	2.36
Length of card	3.52	3.52	3.68	3.68	3.46	3.46
M. E. P.	78.3	72.7	26.5	27.6	11.03	10.92
I. H. P.	91.5	78.3	81.1	81.0	93.2	83.6
		169.8		162.1		176.8

508.7 =total I. H. P.

Size of Attached Feed Pumps

Q. (989).—(1) What is meant by developing one horsepower on 100 pounds of steam per hour? I see often where a certain pump or engine consumes so many pounds of steam per hour. Please explain to me how I may figure the pounds of steam per hour that an engine or pump is using to develop a certain horsepower.

(2) What is the relation of sizes of the cylinders of triple expansion marine engines? Knowing the diameter of the high pressure cylinder, how would you figure out the diameter of intermediate pressure and low pressure cylinders?

(3) Knowing the diameter of a high pressure cylinder of a compound

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engine, working pressure, revolutions per minute, etc., how would you find the size of a single-acting plunger pump to handle the water of condensation from filter box to boiler as a feed pump—the pump to make a stroke with every revolution of engine?

A. (989).—(1) In marine practice, steam consumption of engines and turbines is commonly expressed as so many pounds per horsepower per hour. Accurately to find the steam consumption of a certain engine requires that the condensed steam used by the engine be weighed over a definite period of time. The average indicated horsepower during this period may also be computed by taking cards and other data. It is an easy matter to obtain the amount of steam used per hour for the main engine. Dividing this quantity by the average indicated horsepower will give the steam consumption per indicated horsepower per hour.

(2) The relative sizes of engine cylinders of a marine engine depend partly on the boiler pressure. To save weight, the designer may find a certain size desirable. A common rating for merchant type engines working at 160 pounds pressure is the following:

$$\text{Intermediate } \frac{\text{L. P.}}{\text{H. P.}} = 2.6 \quad \frac{\text{L. P.}}{\text{H. P.}} = 6.8.$$

Since the cylinders have the same length of stroke, the following relation for the intermediate pressure cylinder will hold:

$$\frac{\frac{\pi}{4}(D_2)^2}{\frac{\pi}{4}(D_1)^2} = \frac{2.6}{1}$$

where D_1 and D_2 are diameters of the high pressure and intermediate pressure cylinders, respectively. In a similar manner the diameter of the low pressure cylinder may be found. (In a new design the size of the low pressure cylinder is usually determined before the high pressure.)

(3) Attached feed pumps should be installed in duplicate, and each one should have capacity enough (assuming no leakage) to supply double the amount of feed water required. Knowing sufficient data of the main engine, we may estimate its steam consumption. The steam consumed by auxiliaries will be perhaps one-tenth more. If d is the diameter and s the stroke of each attached feed pump, we shall have

$$n \times \frac{\pi d^2}{4} \times s = 2\,W,$$

n being the revolutions per minute of main engine and W the pounds of feed water fed per minute, which, excluding minor leakage, will be the steam consumption of main engines and auxiliaries. The stroke of pump may be one-third to one-half that of the engine.

ORGANIZING THE EMPLOYMENT DEPARTMENT.—As it is becoming increasingly difficult to supply skilled workers for shipbuilding, the shipyards are confronted with the problem of increased production with a decrease in the supply of workmen. In order to keep up production under these conditions, most careful thought must be given to the selection, placement and methods of retaining a competent and loyal force of workers. As an aid in accomplishing this result, the employment management branch of the Industrial Service Section of the United States Shipping Board Emergency Fleet Corporation is issuing a series of bulletins dealing with the proper handling of employment problems. The methods and processes outlined are those that have been found useful by some of the largest shipyards and corporations in the United States.

NEW BOOKS

PRACTICAL SHIPBUILDING. By J. D. MacBride. Size, 5 by 7½ inches. Pages, 231. Illustrations, 100; folding plates, 2. New York, 1918: D. Van Nostrand Company. Price, $2.

In the great army of volunteers which responded to the nation's call for men to build our emergency fleet, few had any knowledge of ships or shipbuilding. To initiate such men into the intricacies of shipyard work, the author has compiled a handbook in which are explained in simple language the functions and nature of the work of the various departments in a shipyard, the duties of each group of workers and their relation to each other. The various shipyard tools and appliances are described, together with the parts of a standard type of cargo steamship, and this is followed by a glossary of shipbuilding terms. The book is purely descriptive and does not enter into the engineering features of shipbuilding, but it will prove a valuable aid for new men starting in shipyard work.

AIDS TO EMPLOYMENT MANAGERS AND INTERVIEWERS ON SHIPYARD OCCUPATIONS. Size, 6 by 9 inches. Pages, 147. Philadelphia, 1918: United States Shipping Board Emergency Fleet Corporation.

As it is more economical and more expedient to spend five or even ten minutes in properly placing a new worker in a shipyard than it is to spend two hours or sometimes two days in trying to replace him, employment managers and interviewers will find it advisable to consult this carefully compiled handbook which lists the occupations and describes the trade, physical and mental requirements as well as the education and experience essential for applicants to qualify for the various positions in a shipyard. The book is one of a series on employment management supplied by the employment management branch of the Industrial Service Section of the Emergency Fleet Corporation. A supplement will be issued covering the shipyard occupations in which handicapped persons of various types can be employed.

MODERN SHIPBUILDING TERMS DEFINED AND ILLUSTRATED. By F. Forrest Pease. Size, 5 by 7¼ inches. Pages, 143. Illustrations, 82. Philadelphia, 1918: J. B. Lippincott Company. Price, $2 net.

Some two thousand terms applied to ships and shipbuilding, 350 of which are illustrated, are clearly and concisely defined in this book. The illustrations, most of which are reproductions of photographs taken in our best-equipped shipyards, are an especially valuable feature, as the parts of ships or shipways defined are clearly indicated with reference letters or figures. Several appendices contain more complete explanations of the shipyard trades and the duties performed in each, as well as of electric and gas welding and the Isherwood system of shipbuilding.

STEEL SHIPBUILDERS' HANDBOOK. By C. W. Cook, M. A., B. S. in C. E. Size, 4½ by 7 inches. Pages, 123. Folding plates, 4. New York, 1918: Longmans, Green & Company. Price, $1.50 net.

This handbook is an encyclopedia of names of parts, tools, operations, trades, abbreviations, etc., used in the building of steel ships. About 1,600 names are defined and 300 parts illustrated. The definitions have been arranged alphabetically and cross-referenced as completely as possible. The work is the result of a careful study of the latest and best methods used in the large shipbuilding plants all over the country and of the best text-books on steel shipbuilding.

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Shipbuilding and General Marine News

Contracts for New Ships—Shipyard Improvements—Engineering Projects—Improved Appliances—Personal Items

EXTENSIVE ADDITIONS TO UNITED STATES NAVY PROPOSED BY NAVAL BOARD

Three-Year Programme Calls for Sixteen New Battle Cruisers and 108 New Destroyers

As outlined by Rear Admiral Badger before the Naval Affairs Committee, the General Naval Board contemplates adding sixteen new battle cruisers, according to the 1920 three-year building programme, to the six which are already under construction. The United States would then have twenty-two superdreadnoughts of the most advanced type.

The new programme also calls for 108 new destroyers. At present the Navy possesses about 500, and authorization has already been given for the building of at least 342 more.

The six battleships about to be laid down will carry a main battery of twelve 16-inch guns. They will have a total displacement of about 43,000 tons and can maintain a speed of 23 knots under ordinary operating conditions.

The new three-year program as recommended by Secretary Daniels would mean an appropriation of $600,000,000 to insure the completion of plans which he considers essential for the maintenance of our position in the partnership policing of the high seas. If a league of nations, or special terms of the peace treaty shall make it of less necessity for individual nations to have large navies, the program will undoubtedly be revised along these lines.

Schwab's Resignation Accepted

With the shipbuilding programme well advanced and adequate machinery in operation to carry on the work of building up a large merchant marine, Director General Schwab feels able to turn his attention to the affairs of the Bethlehem Steel Company again. The services which he has rendered to the whole country by his unqualified success in pushing through the shipbuilding programme cannot be estimated.

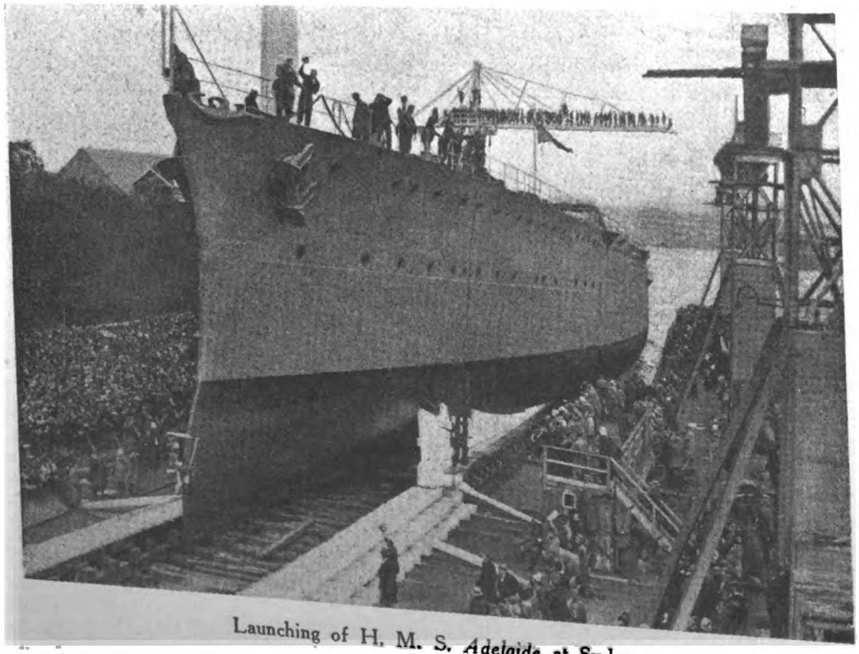
Shipbuilding Profits in Japan

Shipbuilding is evidently profitable in Japan. The directors of the Osaka Iron Works have decided to pay a dividend of 35 percent for the last term, or 10 percent higher than for the preceding half year. The net profit realized by the Kawasaki Dockyard Company during the first half year amounted to 14,030,000 yen.

Australian Warship Adelaide Launched

His Majesty's warship *Adelaide*, launched from the slipway at the Commonwealth Naval Dockyard, Cockatoo Island, Sydney, is the largest ship ever built in any part of the British dominions. The christening ceremony was performed by Lady Helen Munro Ferguson.

This ship was launched in much less time than the last warship, due, probably, to the absence of labor disputes, the improved machine tools and the increased experience of the workmen. Practically all of the material for the construction work of the hull was imported.



Launching of H. M. S. *Adelaide* at Sydney

FINDINGS OF HOG ISLAND INVESTIGATION MADE PUBLIC

No Grounds Found for Criminal Prosecution, but Careless and Extravagant Expenditures Alleged

Since the issuing of the report of the Department of Justice concerning conditions at the Hog Island shipbuilding plant on December 20, the country has been in possession of the facts upon which previous criticism has been based. The investigation, made by two assistants to the Attorney General, aided by two naval technical advisers, Civil Engineer Archibald L. Parsons and Naval Constructor S. M. Henry, covered facts observed from February, 1918, through the early part of July.

When the American International Corporation—composed unofficially of the engineering firm of Stone & Webster and the New York Shipbuilding Corporation—agreed to buy 846 acres of land at Hog Island to be utilized for shipbuilding purposes upon a 6 percent rental basis, the estimated cost of constructing the yard was $21,000,000. Subsequent changes added $2,750,000 on account of the additional seventy ships later contracted for, and $3,250,000 on account of subsoil conditions, etc.

The investigating committee very frankly stated that they found no evidence, except certain minor frauds, as grounds for a criminal prosecution. They were, however, decided in their condemnation of careless and extravagant expenditure.

Waiving all minor questions of controversy, the outstanding fact is that the agent's summer and fall estimates of $21,000,000 and its November 27 estimate of $27,000,000 have been so far exceeded that the probable cost of the yard will be about $61,000,000 (including $6,000,000 for recent additions).

The most significant single fact indicating the point of view at Hog Island was that bills for material, largely lumber, were prepaid (and properly prepaid) to the extent of over $10,000,000, but no effort was made to check the actual receipt of the material paid for.

As a means of comparison, it was cited that the total cost of $1,100,000 per slip at Hog Island is hardly compatible with the report that the cost at Bristol was only $699,000, and at Newark Bay $390,000.

As a satisfactory handling of the situation, the committee recommended that it would be advisable to submit the matter to a board of arbitration, to consist of three distinguished naval architects—one selected by the committee, one by the Fleet Corporation and one by an agent of both parties involved.

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COLUMBIA ORGANIZES NEW CLASS FOR SHIP DRAFTSMEN

Brooklyn Polytechnic to Teach Marine Engineering

The evening classes at Columbia University, covering ship drafting, which were opened as a war necessity, will be continued to supply competent men for drafting positions in the post-war developments. These classes are planned under the direction of Thomas H. Harrington, professor of mechanical drafting; Arthur Bolton, M. I. N. A., chief hull draftsman, Federal Shipbuilding Company, formerly with New York Shipbuilding Company, Sun Company and Argentine Naval Commission, and Richard F. Bach, curator at the school of architecture.

The Polytechnic Institute, Brooklyn, is organizing a new evening course in marine engineering, to start shortly after January 1. The course is planned for those who are now employed in some of the various forms of marine activity in New York and vicinity who intend to remain in the field and who feel the need of supplementing their present qualifications by further study. It will include the study of the steam power plant of a modern ship, calculations involved in its design and construction, also testing and operation. Subjects of resistance and propulsion will also be included, and consideration given to the design and operation of the internal combustion engine. The course will be conducted under the direction of E. S. Church, Jr., professor of mechanical engineering.

WELIN MARINE EQUIPMENT NOW INCORPORATES WITH AMERICAN BALSA

Brings Raw Material and the Manufacturer Together

The American Balsa Company, Inc., has recently been organized, with a capital of $1,000,000, to take over the Welin Marine Equipment Company and the American Balsa Corporation, with offices at 50 East Forty-second street, New York City. Directors of the American Balsa Company are: A. P. Lundin (chairman), B. C. Carpenter, J. F. Case, George S. Lewis, George Mixter, William Finlay Morgan, R. B. Sheridan, C. C. Stillman, Beekman Winthrop. The officers are: George S. Lewis, president; A. P. Lundin, William Finlay Morgan, S. B. Sheridan, vice-presidents; Cecil Page, secretary; Percy Mayes, treasurer. At the present time the American Balsa Company is operating plants at Long Island City, Astoria, L. I.; on the Harlem River, New York, and Delawanna, N. J. Practically the entire output is taken by the United States navy, the United States Army Transport Service and the Emergency Fleet Corporation. The principal products are Welin davits and Lundin lifeboats, standard for United States transports, special buoys, Balsa wood for hydroplane construction and A-B-C liferafts and life preservers. As soon as war conditions permit, the manufacture of insulation material, especially for refrigerator ships, will be developed.

PLAN RECONSTRUCTION OF BELGIAN COMMERCE

Royal Belge in the Market for Ships—Twenty-four Destroyed by Submarines—Belgian Agents Seek Business

War-scarred Belgium has taken the first steps toward commercial rehabilitation by planning the immediate expansion of the Royal Belge fleet. The corporation was organized when the war broke out, with H. Arthur Brys at its head, and at once turned over to the Belgian Government a fleet of forty ships for war purposes. Only sixteen vessels now remain; the other twenty-four having been sunk by submarines or mines. Twelve of the remaining ships are temporarily flying the British flag, carrying supplies to France and acting in the service of Belgian relief.

Expansive developments, however, are immediately contemplated, and Joseph A. Nash, for four years general manager of the Shipping and Purchasing Department of the Committee for Relief in Belgium, has established offices at 141 Broadway, New York City, to undertake the work. The organization, which is backed by King Albert, is in the market for ships. It is hoped that connections will soon be re-established with the Antwerp office and the actual rehabilitation of the commercial venture begun.

The speed with which she does this will depend upon two factors—the amount of industrial rehabilitation accomplished at home and the number of vessels she will have at her disposal for import and export. There is one thing which Americans must bear in mind—Belgium still has huge resources.

With the signing of the armistice progressive Belgium agents are already seeking opportunities to become representatives of American manufactures in the rehabilitated country. W. C. L. Lamont, whose present address is 22 Northumberland avenue, London, W. C. 2, is planning to return to Antwerp, and will be open for propositions to handle American products.

Mr. Lamont's previous connections with the Association des Industriels Belges, Etablis dans le Royaume-Uni, Secretary to the Ligue Maritime Belge. (Section Britannique), member of the Government advisory committee for Belgian inland transportation (London), and secretary and treasurer to the Belgian Barge Owners' Federation, are sufficient recommendations to establish his familiarity with the marine field.

U. S. Ship Loss was 138 Vessels

From war causes the American merchant marine lost 138 vessels, totaling 311,868 gross tons, with a loss of life of 500 persons. These figures are based on the reports of the United States Bureau of Navigation. The American tonnage lost is less than one-fifth of the British losses and less than one-third that of all other Allies and neutrals.

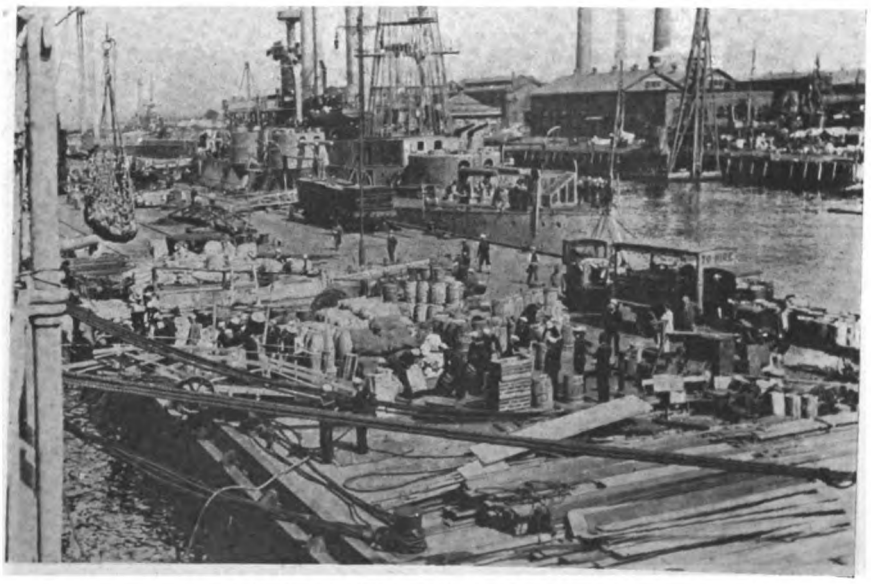
Only one American vessel of over 10,000 tons was lost—the tanker *O. B. Jennings*, 10,289 gross tons, sunk during the U-boat activities of last August. Out of the total of 138 American vessels sunk only nineteen were over 5,000 gross tons.

The above figures take no account of losses of ex-enemy or ex-Dutch steamers which were temporarily under our flag.

PRESIDENT LANDS AT BREST

Harbor Improvement Made to Handle Army Shipments

Since our entry into the war the harbor of Brest has been deepened and equipped with the most modern terminal facilities, to speed the landing of ordnance and food supplies for the American troops in France. This is probably one of the largest, most advanced engineering feats undertaken within recent years, and has been completed with phenomenal speed. It is fitting, therefore, that the port, which is also the largest naval base of the United States forces abroad, should welcome the President to France on December 13.



Shipping Activity at the Harbor of Brest

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Huge Gang Drill for Steel Work

Three minutes to drill 18 feet of circular seam on the flat with one setting of the machine is the record of a huge gang drill invented and designed by Aaron Hill, Los Angeles, California. This new machine, which has an eighty-drill capacity, can be set to any ordinary assembly desired. Spacing is facilitated by a steel scale on the machine, thus entirely eliminating laying out or the use of tack holes in the plate previous to rolling. The machine can handle angles of every shape, channels, I- and H-beams, and plates of any length.

The machine is particularly valuable for boiler work. Here it eliminates the older, slower process of punching small holes and then rolling shell plates and reaming. Warping, dishing, stretching and crystallizing of the metal are, accordingly, dispensed with, and in assembling the delay and annoyance of making oversized holes.

In drilling the drums of boilers the inner butt strap is placed upon the beam, and held in position by special gage bolts. The beam is then run inside of the drum shell, which is already rolled up without holes in it. By special slings the beam and drum are lifted onto cradles. The outer butt strap is then placed in position, when the automatic clamps with which the machine is fitted clamp the straps and drum down upon the beam with a pressure of over 20 tons. Set and spaced, the drill runs one complete row longitudinally and then releases itself automatically.

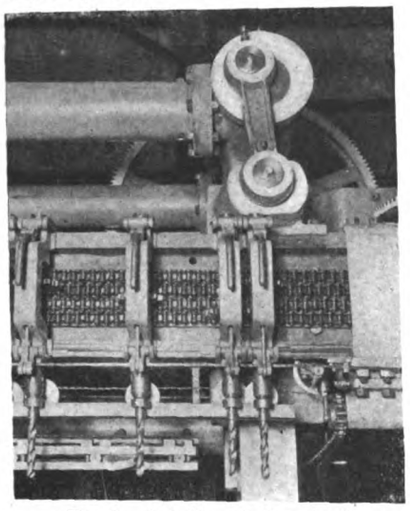

Fig. 1.—Spindles of Gang Drill

The cradle is geared so that it can be moved circumferentially to bring the next pitch in line for drilling the next row of holes. The handles shown in the front of Fig. 1 make it possible to remove any spindle which may not be required for certain drilling. Larger spindles can also be put in place and 3¼-inch tube holes drilled—thirty-two can be accommodated at once. Four of these drills are being built by the Badenhausen Company, manufacturers of watertube boilers, 1425 Chestnut street, Philadelphia, at their Bound Brook factory. The first one is installed at the boiler shop at Cornwells, Pa.

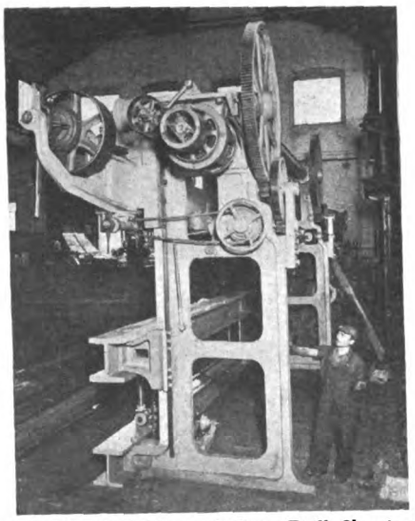

Fig. 2.—End View of Gang Drill Showing Driving Mechanism

French Inland Waterway Development

A project for the construction of a canal between Paris and Dieppe is now receiving consideration. The scheme is the revival of a very old plan. It is believed that the trading conditions which will prevail after the war have given the project a new importance. The Seine is not able to deal with the traffic that is now offering, and there have been as many as seventy ships in the estuary awaiting their turn to enter Rouen, besides 1,300 barges awaiting their turn to leave. The canal is designed to accommodate the largest boats at present traversing the French waterways, which carry 1,400 tons, and are 88 meters in length, with a draft of 3 meters when loaded. The barges are to be hauled by electric locomotives running on a track alongside the canal or on a roadway. The canal would be 165 kilometers in length, as compared with the route by the devious River Seine, which is no less than 350 kilometers long.

U-Boat Toll Reaches 15,000,000 Tons

The world's sinkings since the outbreak of the war down to September 30 last, according to the figures of the British Admiralty, were 14,825,635 gross tons, distributed over the war years as follows:

1914 (five months)	681,363
1915	1,724,720
1916	2,797,866
1917	6,623,623
1918 (nine months)	2,998,063
	14,825,635

This means that the U-boats destroyed almost exactly one-third of the amount of steam tonnage in existence in the world when the war broke out. The toll of destruction is greater than the combined merchant fleets, at the beginning of the war, of the United States, Norway, France, Japan, Italy, Sweden, Austria and Holland. It is almost equal to the steam tonnage of Britain in August, 1914, which was 18,892,089 gross tons.

Snap Switch for Marine Service

A new switch for marine purposes is here illustrated. The base is of unbreakable molded composition with ratchet plates also molded—thus eliminating the possibility of the mechanism becoming loose. The ratchet is, of course, made of steel to stand up in severe service, but is copper-plated to prevent rusting. The music wire spring, which actuates the mechanism, is also heavily copper-plated. This switch is made by the Bryant Electric Company, Bridgeport, Conn., in both single and double pole. Where watertight covers are employed a ⅜-inch extension stem for handle is offered. The size of the bases, as molded, accommodates standard screw spacings for attaching the switch to the box. A groove is provided on the back of the base of suitable size to permit the running of a separate circuit through the box.

Bryant Marine Snap Switch

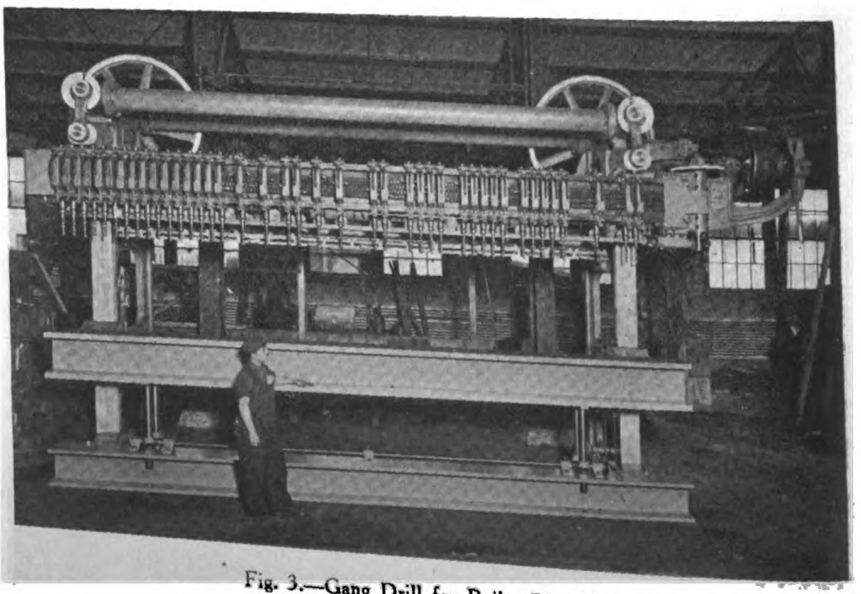

Fig. 3.—Gang Drill for Boiler Plate Work

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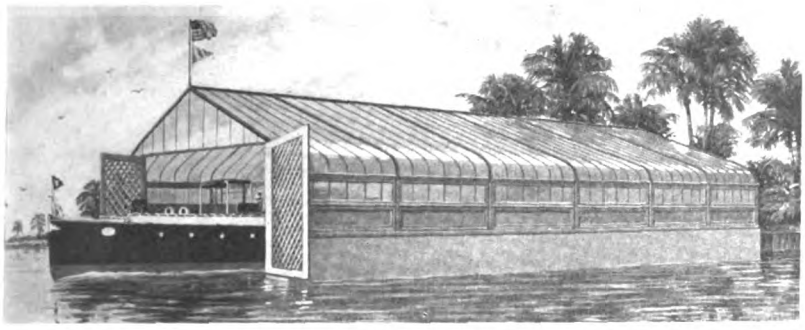
Glass Boat House

An unusual yacht novelty in sub-tropical regions is furnished by the new glass boat house which is being built for Lee R. Rumsey, of New York City, at his winter home at Alton Beach, Miami, Fla., probably the first glass boat house ever constructed. Glass has been widely used in the construction of conservatories and swimming pools; its application, however to boat houses comes as a distinct departure, though, when its advantages for this purpose are considered, it is a wonder that no one thought of it before.

The boat house is of pleasing lines, with curved eaves. With the roof and sides constructed of glass there is little chance of mildew. It can be washed down with a hose from top to bottom. There is not a dark spot in the whole structure. The supporting framework is of cast iron and steel, heavily galvanized. The glass used in glazing is ground, which softens the direct rays of the sun, while giving the maximum amount of light. The double doors are of wood, with an open lattice pattern that insures good air circulation.

In designing the structure the architects, Lord & Burnham, of New York City, aimed to secure conditions approaching a boat at anchor, with a suitable covering to shield it from the weather. The foundation is of concrete.



Glass Boat House for Southern Waters

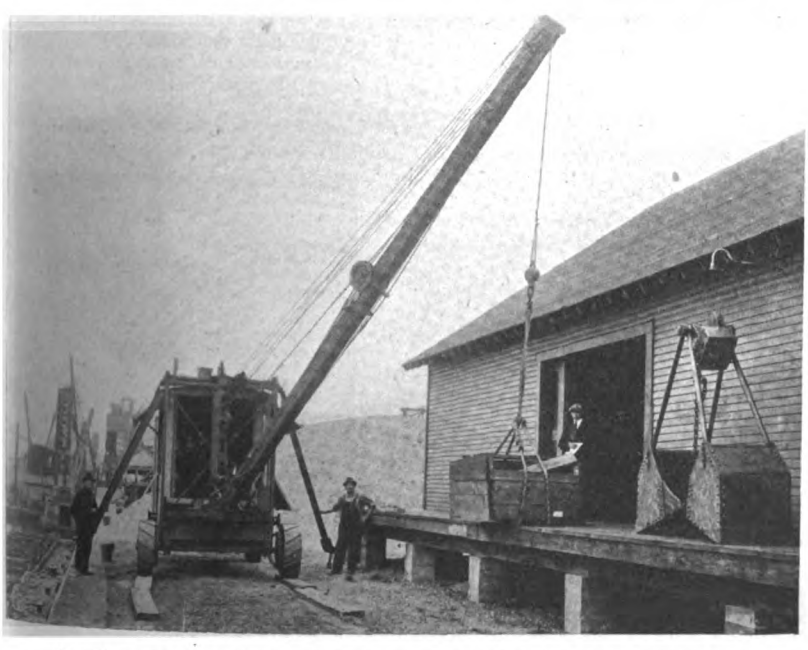
Auto-Crane for Terminal Freight

The concentration in shipping incident to the present emergency has served to emphasize the demand for more efficient means of handling freight at terminals. The extension of inland water traffic has created a similar "urge." Varied apparatus is constantly being originated to handle this new and developing situation.

Among efficient machines stands the "Auto-Crane," eighteen of which are being used on the New York State Barge Canal at various terminal points for unloading and loading freight from the barge. The accompanying illustration shows one of these cranes. This crane, which is manufactured by the John F. Byers Machine Company, Ravenna, Ohio, is all-steel. Being of the semi-locomotive, self-propelling type, either forward or reverse, it is particularly adaptable for operation where the moving of the apparatus is necessary to cope with the varying loading and unloading conditions. In fact, these cranes have been installed by the War Department at Bush Terminals in Brooklyn, Newark, Norfolk and Charleston, S. C., to more efficiently handle freight from cars at terminals.

The Auto-Crane can be equipped with three kinds of power—steam, gasoline or electricity. Three kinds of mounting are also available—road wheels, rail trucks and caterpillars.

It is capable of handling loads up to 3 tons at 12-foot radius, when being used in connection with hook for derrick work; when used for loose material handling, with clam-shell bucket, it will satisfactorily handle a ¾-yard clam-shell bucket of 2,400 pounds. It will accommodate orange peel buckets up to half a cubic yard in size.



Auto-Cranes Used on New York State Barge Canal and at Bush Terminals

"Faithful Service" Badges Awarded on the Great Lakes

In the October issue of MARINE ENGINEERING an article appeared claiming that the employees of the Passaic River yard of The Foundation Company were the first to be awarded badges for "Faithful Service" by the United States Shipping Board.

Foundation Company's Service Badge

It may be of interest to know that the Cleveland office of the United States Shipping Board was among the first, if not the first, to use this method of awarding its faithful employees.

The Cleveland office of the United States Shipping Board awarded "Faithful Service" badges for the three consecutive months of July, August and September of this year. The illustration shows the design of badge used. The color scheme for the July bar was a red background with gold letters; the August bar was white and gold and the September bar blue and gold. When the badge was presented a bar was attached. It has been the intention of the Shipping Board to inspire the men in the shipyards to continue to perform faithful service and win the other two bars, thereby showing a perfect record at the end of three months by winning the national colors. This would necessitate that the men remain in one place, and not shift from one yard to the other.

About sixteen hundred and sixty-five badges have been presented to the men

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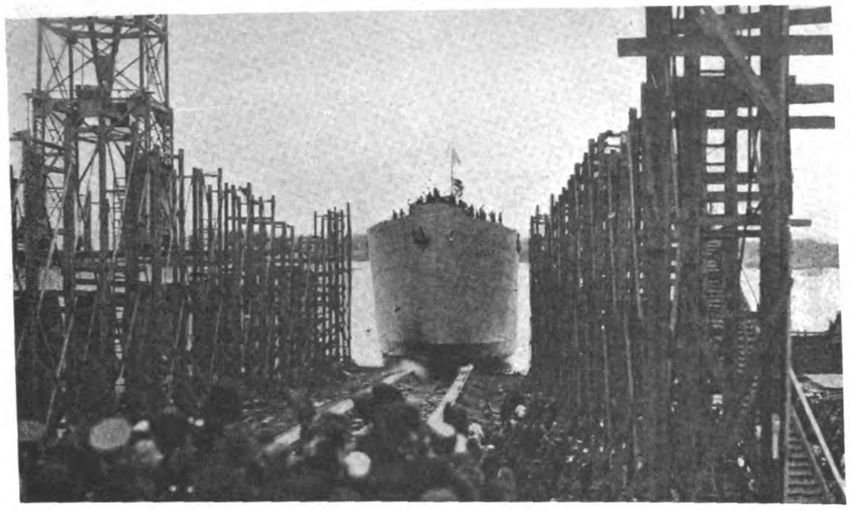
in the Great Lakes yards. Many have won the three bars.

In years to come the possessor of one of these badges can look back with much pride and satisfaction to the fact that he "did his bit" in helping to build "the bridge of ships" which will constitute the world's greatest merchant marine after the war. It is "Faithful Service" on the part of the men in the shipyards that is making this possible.

RECENT LAUNCHING RECORDS

America and Great Britain Still Full Speed Ahead

The 9,400-ton deadweight ship *Diablo*, the first of ten contracted for by the Shipping Board from the Pacific Coast Shipbuilding Company, was launched on Suisun Bay, November 30.



Freighter *Tollard* Taking the Ways at Groton, Conn.

The steel freighter *Tollard*, which was launched on November 9, at Groton, Conn., is shown taking the ways in the accompanying illustration. Ground was broken for the construction of the Groton Iron Works shipyards, where this boat of 8,800-ton capacity was built, a little over a year ago.

The first concrete boat built in New England is the record of the Aberthaw shipyards. This boat, launched December 7, is the first of a number of lighters under construction by that company. It is 110 by 34 feet, with a depth of 11½ feet, flat bottom, square sides and sloping ends, and is divided into fifteen watertight compartments. It has a deadweight tonnage of 418 tons, with 500 tons carrying capacity. A second was launched December 21.

The Speedway Shipyard of the Gas Engine and Power Company and Charles L. Seabury and Company, Consolidated, of Morris Heights, New York, put overboard their fourth mine sweeper, *Seagull*, for the United States Navy at 2:30 P. M., December 24.

The Newburgh Shipyards, Inc., Newburgh, New York, launched a third 9,000-ton steamer December 21.

On November 19, a concrete vessel, the *Molliette*, was launched by Messrs. James Pollock Sons & Company, Upper Brents, England, into Paversham Creek. This probably represents the results of the first plans for straight-framed seagoing vessels developed on English soil. The dimensions are: Length over all, 131 feet; breadth, molded, 25 feet; molded depth, 11 feet 9 inches; draft, loaded, 9 feet 9 inches. The vessel is designed to carry 320 tons of cargo. The *Molliette*, which is a reinforced concrete vessel, will doubtless be the forerunner of other concrete vessels for coast trade.

Four large merchants ships were recently launched within ten days from Port Glasgow shipyards, three by Russell & Company, and one by W. Hamilton & Company. The four vessels aggregate nearly 30,000 tons gross. The first 8,000-ton standard vessel built by the Hebburn-on-Tyne yard of Palmer's Shipbuilding & Iron Company, Ltd., has been launched.

Fig. 2.—Workman Suffering from Burn in the Second Degree

Discovery Used to Treat Burns

In line with the utilization of successful war discoveries for peaceful pursuits is the adaptation of "Ambrine," a new surgical dressing, to the needs of American industry, and in that connection, to American shipyards. This dressing, which has been perfected by Dr. Barthe de Sandfort, a retired surgeon of the French army, is composed of certain paraffins and resinous gums scientifically combined to serve as a sealing poultice on burns. Dr. William O'Neill Sherman, chief surgeon of the Carnegie Steel Company, of Pittsburgh, was much impressed with the value of the dressing when he visited the Allied hospital at Issy-les-Moulineaux, where the treatment is used. The preparation has been adopted by the British Admiralty and army, the Belgian and Italian armies, all the French organizations handling the medical situation, and the United States army.

Fig. 1.—Ambrine Kit

In application the material is heated to a temperature of less than 150 degrees F., and the viscous mass applied to the lacerated surface to cover the delicate, exposed nerve ends. The exclusion of air, of paramount importance in dealing with all types of skin and flesh wounds, is thus accomplished by the forming of a semi-flexible surface over the burned parts. Usually a supplementary dressing of medicated absorbent cotton is applied for purposes of convenience, through which heat can be imparted to the tissue.

Actual results obtained by the use of the process are shown in the accompanying photographs. The first photograph shows the very serious condition; the case was termed "burning in the second degree." The second gives the result of the treatment after thirty-five days. The installation on all merchant vessels of these first-aid kits, which supply apparatus for applying the preparation, now produced in American laboratories, is now under consideration by the Emergency Fleet Corporation. The Ambrine Laboratories, 347 Madison avenue, New York City, are placing the product commercially on the market.

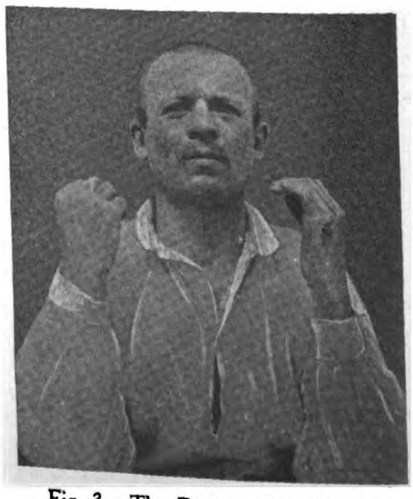


Fig. 3.—The Patient After 35-Days' Treatment

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Unusual Hoisting Apparatus on Large Dredge

By a slight change in design, a floating dredge, which has previously given excellent service on small work, has been converted to handle much heavier work. The unusual feature of the new design is the carefully adjusted balancing apparatus.

The hull of the dredge is about 150 feet long and 50 feet wide; the boom, which is 70 feet on centers, carries a clam or orange peel bucket of 10 cubic yards capacity. The weight of the empty bucket is about 17 tons in air; when filled the bucket weighs 32 tons in air, 22 tons in water. This difference of 10 tons and the weight of the empty bucket cause great irregularity in the hoisting stresses. Accordingly, the bucket has been provided with an adjustable variable-controlled counterweight, so arranged that it will take up about 12 tons of its weight at times. When the bucket is below surface, however, the full weight is utilized to make it sink more rapidly into the material for filling. This compensating arrangement permitting uniform operation of the engines means economy of work and maintenance.

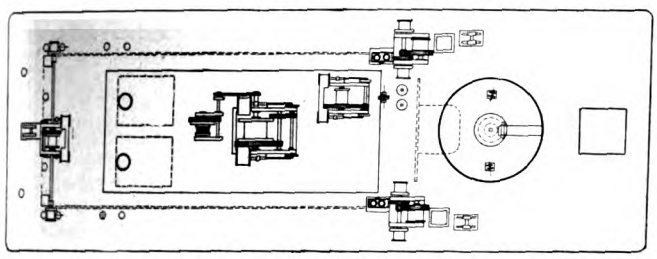
As may be noted from the illustration, the point of the boom is supported by steel cables and swivels at the top of the shear legs 53 feet high. The top of the shear legs is inclined slightly forward, and is attached to a vertical and longitudinal inclined strut about 55 feet long. This strut serves as a track for counterweights with endless cables, as shown, attached to a steel cable passing between horizontal guide sheaves at the shear legs and thence over the sheave at the end of the boom and down to the bucket, which is supported by it. Another line leads over a second sheave at the point of the boom and runs directly back to the main hoisting engine.

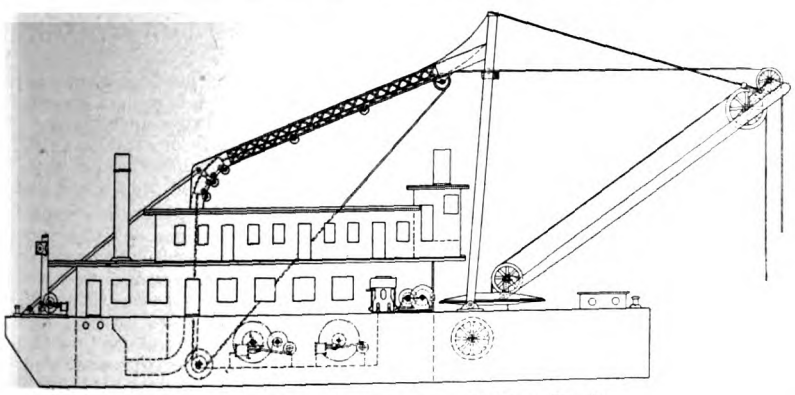
Arrangement of Balancing Counterweight

The proportion of the lines is such that when the bucket is in the water the counterweight is supported by the inclined strut on a track, sufficiently graded to ensure positive motion of the counterweight without causing much tension on its ropes. When the bucket top rises to the surface of the water the counterweight reaches the vertical incline strut. As the bucket continues to rise the counterweight descends abruptly, throwing its full effective weight on the hoisting line, thereby relieving the engine of the extra weight in the air until the bucket again dips into the water; at this point the counterweight slips from the vertical to the incline track, eliminating its tension upon the hoisting rope.

The lower counterweight track is extended aft from the foot of its vertical hoist, hence it can remain in equilibrium at the bottom of the dredge for inspection or adjustment. By this arrangement and the location of the hoisting engine, the counterbalance is always effective and the bucket can be operated at full radius on either side of the dredge.

This dredge, which is about one-fourth smaller than other dredges of equal capacity, has been designed by H. Toomey, and built by Toomey Bros., New York.





Showing Placing of Machinery on 50-Foot Dredge

Iron Ore from Spain and Sweden

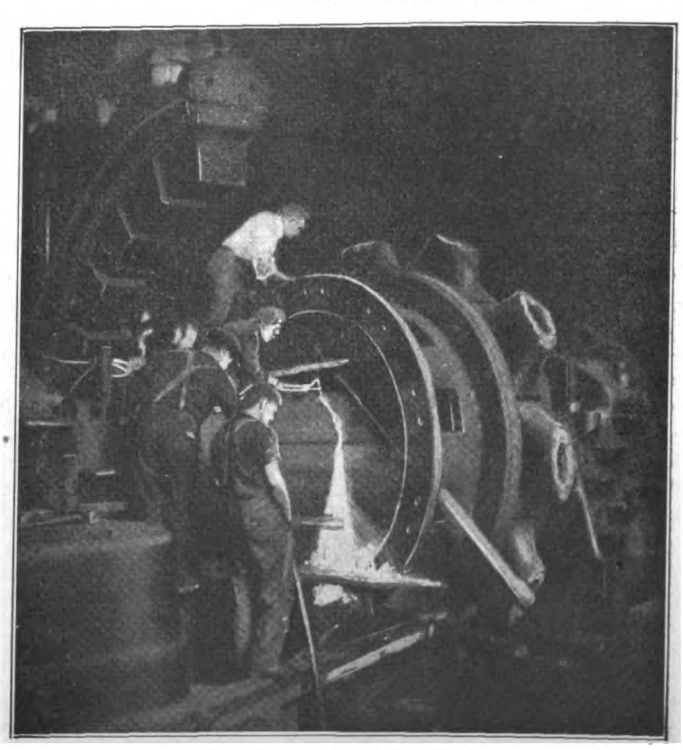
The War Trade Board announces in a new ruling that, in addition to the license covering the importation of iron ore from Sweden and Spain when coming as ballast in ships returning from those countries, licenses may be issued for the importation of a maximum total from all sources of 70,000 tons of low phosphorus iron ore from Spain, Sweden, Norway and North Africa, provided the ore be imported and entered prior to July 1, 1919.

Annual M. E. B. A. Meeting

The Marine Engineers' Beneficial Association will hold its annual convention in Buffalo on January 20-25. "This will be the biggest convention in the history of our organization," said President Brown. "All of our national and district officers will be there, besides delegates from all ports, and several of our members who now hold commissions in the United States Naval Reserves and probably some men distinguished in Government circles. The M. E. B. A. has done much to help win the war, and we are going to make the coming convention an occasion of general jollification over the great victory."

A Job of Heavy Shaft Cutting

For the quick removal of steam pipes to make room for turbine generator sets, a heavy shaft-cutting job was recently put through in a large power house by the cutting equipment of the General Welding & Equipment Company, Boston, Mass. Several 36-inch shafts had to be cut. The cutting was made particularly difficult because of the 26-inch solid steel which it was necessary to penetrate before reaching the inner hole of 10-inch thickness. The illustration shows the "Bulldog" cutting equipment satisfactorily "delivering the goods."



Cutting 36-Inch Steel Shafts

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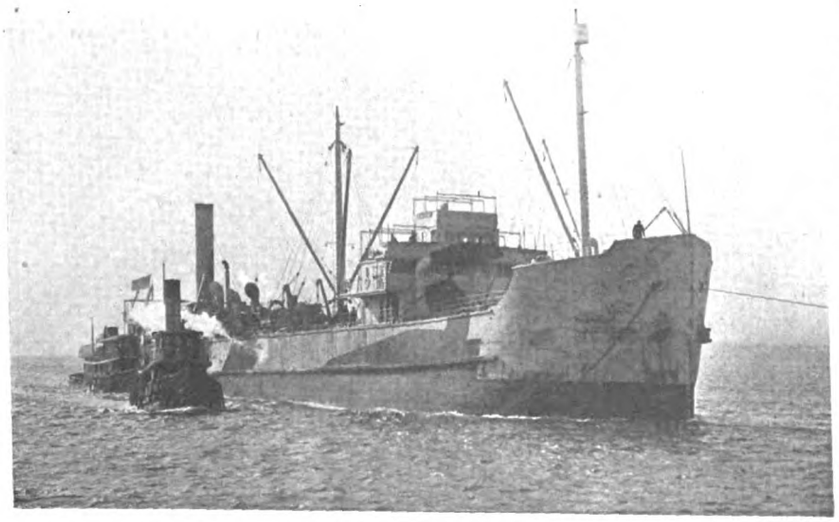

Fig. 1.—Concrete Ship *Faith* Coming Up New York Bay

Concrete Ship "Faith" Reaches New York

The *Faith*, launched in March, at Redwood, Cal., arrived in New York on November 21. Her success was first proved on a trip to Puget Sound, when she weathered a severe storm. Later she carried cargo to San Francisco, then to Peru. She then returned with a cargo of nitrates to New Orleans through the Panama Canal, and now comes from Cuba with a cargo of sugar.

Fig. 2.—Deck of the *Faith* Under Inspection at New York

After discharging her cargo she will be in drydock for inspection and survey. There is great interest among the concrete shipping interests and the members of the International Concrete Ship Association in the East, who have been invited to the inspection. They believe that the very satisfactory results will prove entirely convincing to the shipping world in general as to the practicability of the concrete ship.

Fig. 3.—Another View of Concrete Deck

PERSONAL

GEORGE T. FONDA has recently been appointed general supervisor of Employment, Compensation and Welfare for the Bethlehem Steel plants located at Bethlehem, Steelton, Lebanon, Maryland, Detrick & Harvey and Titusville. In this capacity he will be attached to the office of Vice-President Bent. As organized the department will serve as a clearing house between the different plants.

PROFESSOR C. C. LORENTZEN has recently been appointed director at the Marine Engineering School of the Ocean Association of Marine Engineers at 15 Whitehall street, New York City. As a graduate of the Royal Danish College for Shipbuilding and Marine Engineering, Copenhagen, and with many years' experience in connection with the Danish navy, Professor Lorentzen is well fitted for this important position. Professor Lorentzen has also served as professor in the School of Applied Science, New York University, as head of the Department of Mechanical Drawing and assistant in the Department of Experimental Engineering.

C. T. HENDERSON has resigned his position as chief engineer of the Submarine Boat Corporation, Port Newark Terminal, Newark, N. J., to become chief engineer of the Hercules Engineering Corporation, 501 Fifth avenue, New York City, also acting president of the Electrolytic Engineering Corporation at the same address.

L. E. SHUMACHER, who for the last eight years has been chief inspector at the Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa., has taken the position of works manager of the Krantz Manufacturing Company, Brooklyn, N. Y., the latest subsidiary of the former company.

OBITUARY

BERNARD NADAL BAKER, of Baltimore, retired capitalist, shipping expert and a former member of the Shipping Board, died in Los Angeles on December 20, after an illness of three days. Mr. Baker was president of the Atlantic and Pacific Transport Company, formerly president of the Baltimore Trust and Gurantee Company, and a director in many commercial enterprises. He was also one of the moving spirits in the creation of the Shipping Board.

BUSINESS NOTES

L. F. Body, formerly with the Master Builders' Company of Cleveland, Ohio, has joined the sales organization of the Glidden Company, Cleveland, as manager of railways, street railway and marine sales.

L. C. Sprague, who has been appointed assistant secretary of the Chicago Pneumatic Tool Company, has established offices at 52 Vanderbilt avenue, New York.

Hamilton & Chambers, 29 Broadway, New York City, have been retained as consulting engineers in the building of the new drydock for Providence, R. I.

Joseph T. Ryerson & Son, of Chicago, have opened an office in the Widener building, Philadelphia.

Hayden F. White, who has represented the Independent Pneumatic Tool Company, of Chicago, in the Detroit, Chicago and Milwaukee districts for some years past, has opened a branch office at 1103 Citizens building, Cleveland, Ohio.

The Brown Hoisting Machinery Company announces the following changes in its organization: Harvey H. Brown, chairman of the board of directors; Alexander C. Brown, president; Melvin Pattison, vice-president, general manager and director; Robert G. Clapp, director; John F. Price, director, and Ewen C. Pierce, general manager of sales.

William N. Kinney has been appointed general manager of the Portland Cement Association, Chicago, Ill.

Following the special meeting of the Pratt & Cady Company, Hartford, Conn. held on Monday, December 2, the official personnel of the company now comprises: W. B. Lashar, president; B. I. Ashmun, vice-president and general manager; E. L. King, secretary-treasurer; O. L. Beach, assistant secretary; A. E. Oldroyd, assistant treasurer. The company recently purchased the property and business of I. B. Davis & Son, and will continue the manufacture of feed-water heaters, hot water generators and power pumps.

Fairbanks, Morse & Company, Chicago, Ill., announce the following changes in personnel: R. H. Morse becomes vice-president, in charge of purchasing and traffic, retaining his position as director of the company; C. W. Pank becomes vice-president, in charge of sales of all factory products; W. S. Hovey has been elected vice-president, in charge of general manufacturing at all factories, and W. E. Miller becomes treasurer in place of F. M. Boughey, now secretary and comptroller.

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